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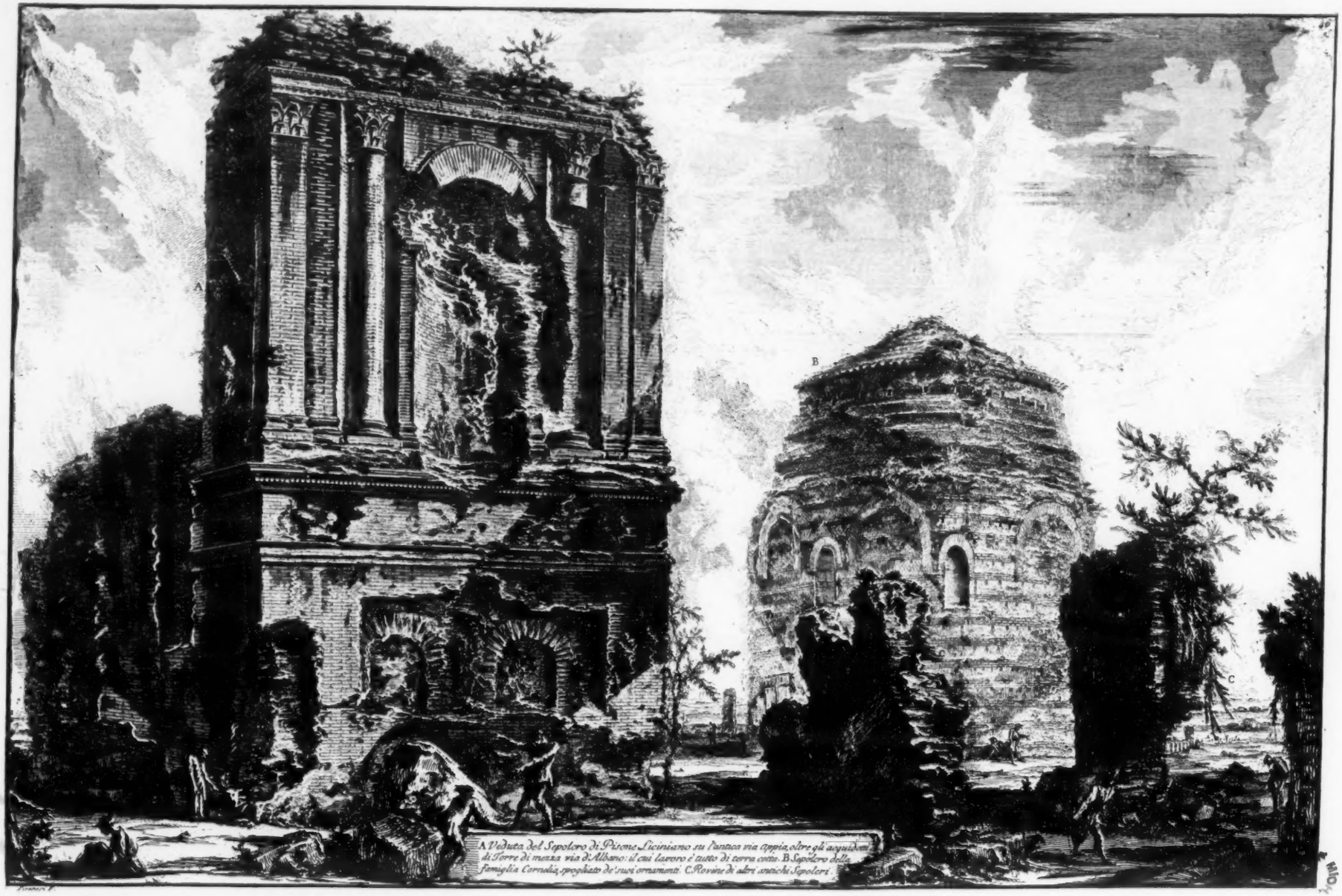
A Veduta del Sepolcro di Pitone Liciniano su l'antica via appia, oltre gli acquidotti
di Torre di mezza via d'Albano: il cui lavoro è tutto di terra cotta. B Sepolcro della
famiglia Cornelia, spogliato de' suoi ornamenti. C Rovine di altri antichi Sepolcri.

RUINS ON THE APPIAN WAY NEAR ROME, BETWEEN THE 8TH AND THE 9TH MILESTONES.

GIOVANNI BATTISTA PIRANESI, DEL.

In 1850 Pope Pius IX. commissioned Canina to excavate the Appian Way as far as the 11th milestone. Canina's book enables us to identify many of the monuments unknown or misnamed at the time when Piranesi worked. The brick monument at the left in Piranesi's engraving is identified as the tomb of Q. Verannius, possibly the same who died in Britain in A. D. 55. The round tower on the right belonged to a structure large enough so that it was dedicated as a Christian church some time before the 10th century.

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VOL. XIX. NO. 5. MAY, 1910.

Hints on Architectural Acoustics.*

BY HUGH TALLANT.

INTRODUCTION.

AMONG the multitudinous qualifications required of the modern architect there is no one more vital to the ultimate success of his work than a practical knowledge of acoustics. Almost every public building, whether it be a school, a church, a theatre, or a house of parliament, contains at least one important auditorium; and if in that auditorium the speakers cannot be distinctly understood, the building as a whole falls short of success, no matter what its beauty, convenience, or other architectural excellence. Yet, for some unaccountable reason, the science of determining in advance the acoustic qualities of an edifice — what for lack of a better name we are forced to call architectural acoustics — this essential branch of an architect's training has hitherto been neglected. There is not, to the writer's knowledge, an educational institution in the entire world which provides a single practical course on this important subject, and, with the lone exception of Professor Sabine's articles on resonance and sound absorption,* there does not exist a text-book or treatise from which the architect may glean the slightest practical suggestion.

No one who has not vainly ransacked the standard works for some vestige of concrete information can realize the utter dearth of definite scientific resource. Not only are all quantitative data conspicuously lacking, but even the futile generalities advanced under guise of theoretic recommendation are often in need of amendment. The pioneer in the field of architectural acoustics finds himself everywhere thrown upon his own resources. He must combat the ingrained belief that all acoustic success is now, and ever will be, wholly due to chance. He must himself ascertain every concrete fact required as a basis for his investigations, and if he dare commit his conclusions to writing, he soon finds that what began in a sincere attempt to cast light upon an obscure subject is in danger of developing into a mere assertion of personal opinion. It is assuredly not from choice that in the following pages the writer has been obliged to rely upon an all-too-frequent reference to his own experience.

Public belief and scientific apathy to the contrary, there seems no obvious reason why the laws of sound may not be turned to practical account, as are the laws of pressure and reaction. Our whole theory of the mechanics of materials is based upon assumed elastic properties of matter which are of doubtful uniformity and of complication without end. Yet this theory, which requires a safety factor of not less than four, enables us to erect structures whose monstrous height would have seemed a marvel to our forefathers. On the other hand, the laws of sound are uniform in action, simple, and of a character which facilitates their graphical expression. It is, to say the least, surprising that some one of a thousand practical scientists has not long since put the theory of architectural acoustics upon a working basis. Another generation will doubtless see treatises on this subject as voluminous as the present text-books on construction, and specialists as expert as the heating, sanitary and civil engineers of to-day. No such extensive propaganda is contemplated in the present instance. The object is merely to describe a simple means whereby with rule and compass the architect may approximate in advance the acoustic qualities of an auditorium, and avoid the most serious defects.

In order that an audience may hear with ease and pleasure three conditions must be fulfilled. The sound must be loud, it must be distinct, and it must be of rich and uniform quality. These requirements are closely interrelated, and it is impossible to consider either of them independently of the others. They must be collectively approached from the standpoints of theory, practice and illustration.

Part I of the following treatise will contain such theoretic principles as bear essentially upon the architectural problem, together with the data necessary for computation; Part II will explain how the acoustics of the ordinary type of auditorium may be determined in advance of construction; Part III will illustrate the actual procedure in the case of four successful auditoriums varying from a seating capacity of 150 to one of 2,200. The reader will find nothing marvelous or strange in the suggestions outlined. They attempt no fundamental

* Architectural Acoustics, by Prof. Wallace C. Sabine, published in the *American Architect and Building News*, April to June, 1900, and in the *Proceedings of the American Academy of Arts and Sciences*, Vol. XLII., page 51. All the precise data contained in the following pages were drawn from this one source by the kind permission of Professor Sabine, to whose courtesy the writer owes also the scientific confirmation of many essential points of theory.

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or detailed presentation of so broad a subject. They involve no complicated mathematics, no tiresome calculations, nothing beyond the simple application of half a dozen principles of physics familiar to every high school boy. Yet they comprise a method, which, in actual test, has given unvarying success in a series of auditoriums constructed during the last fifteen years, and which, it is hoped, may now prove of public interest and service.

PART I.

Theoretic Principles.

The sensation of hearing is caused by vibrations which set in motion the mechanism of the ear. Such vibrations occur in all elastic substances and can be transferred from one substance to another. As a rule, however, they must be transferred to the air before they can affect the ear.*

Sound is sometimes defined as the sensation of hearing, sometimes as vibration capable of causing the sensation. Without wasting time over metaphysical quibbles, we shall merely say that *sound is audible vibration*, and that *a single sound is so much of a vibration* (a square inch, perhaps) *as affects a single ear*. Closer discrimination is unnecessary: for if we can control the vibrations, we can control the sensations which they produce, and in this way arrive at any desired result. For instance, suppose that an audible vibration is repeated at fixed intervals of time. If the intervals are long enough, the vibrations will be perceived as separate sounds, but if the intervals be gradually shortened, a point will presently be reached where the sounds will seem to merge into a continuous tone, whose pitch will rise as the intervals grow shorter. This is a simple case where by controlling the rapidity of the vibrations we can control the varying sensations of pitch.

Sound may result from the action of any force capable of producing vibration. When, for example, an isolated explosion crowds back the air on all sides, there is formed a spherical sound-wave of compressed air around the point of explosion, just as a circular ripple is formed around the point where a stone strikes the still surface of a pond. Such a sound-wave expands continually in all directions at a uniform speed of about 1,200 feet a second.

In Fig. 1 the point of explosion is indicated by S, and the spherical sound-wave by the circle X Y Z. The distance S X will amount to 1,200 feet at the end of the first second after the explosion, 2,400 feet at the end of the second second, and so on until the wave strikes some obstruction.

While a speed of 1,200 feet a second would be marvelous for a flying machine, it is infinitesimal as compared with that of other natural forces, such as light and electricity. It is actually less than half the muzzle-velocity developed by modern cannon, and is so slow as to become a serious factor in determining acoustic conditions. Now the shortest perceptible space of time is about $\frac{1}{15}$ of a second. This corresponds to only 80 feet of sound travel, so that the speaker's voice occupies a very distinct space of time in reaching the rear of an auditorium 100 feet in depth.

* The phenomena of the audiphone and of the action of water against the ear-drum have no importance in the present connection.

As sound recedes from its original source its intensity diminishes as the square of the distance from its origin increases. At 100 feet from the starting-point it is only one-quarter as loud as at 50 feet, and at 150 feet only one-ninth as loud. On the other hand, if we could bend the wave out of shape so that several parts of it would converge upon the same point, we might in this way reinforce the sound sufficiently to offset the natural diminution. If we could make four parts converge at 100 feet, or nine parts at 150 feet, from the starting-point, we might form a combination that would be as loud as the natural sound at 50 feet. This is exactly what happens in the case of the ordinary speaking tube. Here the interior surface of the tube forces the entire sound-wave to concentrate in the same direction, and consequently there is no decrease in the intensity of the sound except through friction against the inside of the tube.

Now if we could extend the same process to an auditorium, and arrange the walls and ceiling so as to concentrate the sound wherever needed, we should be in a fair way to solve the problem of *loudness*. All that we should need to know for this purpose would be exactly how sound is deflected from the walls of a room, and how much is incidentally lost in the impact.

Fortunately there is no lack of theoretic information on this point. The text-books are agreed that a sound is deflected from a wall just as a billiard ball is deflected from the cushion. We all know what happens in the case of the ball. Independent of English (which has an unimportant analogy in the case of sound), the ball rebounds from the cushion at exactly the angle at which it struck, but with diminished momentum. If the original impetus was sufficient, the ball may take a second or third cushion, but with repeated deflection its momentum will eventually be destroyed, and it will come to rest. The exact diminution in momentum depends mainly upon the material of the cushion, but the quality of the ball and the angle of impact also have an influence. An exactly analogous process takes place in the case of a sound. Upon striking a wall it is deflected back into the air at the same angle at which it struck, but with diminished intensity. If it was originally powerful enough it may continue on to a second or third wall, but eventually its momentum will be entirely absorbed, and it will die out. The diminution in loudness occurring with each deflection depends mainly upon the material of the wall, but the pitch of the sound and the angle of impact also have an influence. The precise absorbing-capacity of different materials for the pitch of middle C is enumerated by Professor Sabine in the treatise already mentioned, together with a discussion of the effect of changes in pitch. For ordinary purposes it is sufficiently accurate to disregard altogether the influence of pitch and angle of impact, and to consider only the material of the wall. The following approximate classification will be found convenient:

Wall, floor and ceiling surfaces — such as wainscoting, wood or marble flooring, plastering, glass and masonry — absorb no sound.

Heavy curtains, rugs, and carpets without batting absorb one-quarter of the sound.

Carpeting upon heavy batting absorbs one-half of the sound.

Cushions, ordinary upholstery, and heavy felting hung free from the wall absorb three-quarters of the sound.

The audience and very heavily upholstered furniture absorb all the sound.

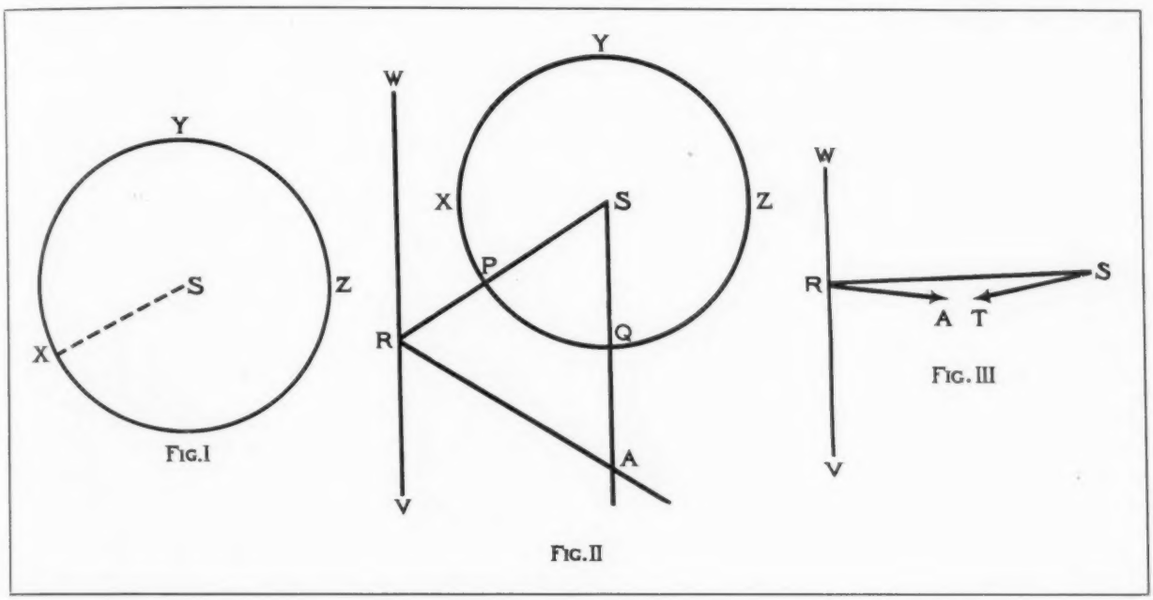
In practice the above table gives results which can be relied upon within about five per cent, except in the case of carpeting, which varies some ten per cent either way with conditions of quality, wear, and amount of batting. At the pitch of middle C, masonry or plaster walls and ceilings actually absorb only some two or three per cent for each impact, and wood sheathing only about six per cent, while the audience absorbs ninety-four per cent. A sound may, therefore, be deflected two or three times from walls and ceiling without losing so much as one-tenth of its volume, whereas as soon as it reaches the audience it is almost entirely absorbed.

Knowing the amount of sound lost in each impact and the exact angle of deflection, it becomes possible to trace the path of any sound from the time it leaves the speaker's lips until it reaches the audience, and to calculate how much of its intensity is lost in transit. In point of fact not over one-quarter of the speaker's voice ever travels straight to the audience, the remaining three-quarters being directed first to the walls, floor or ceiling. By proper curvature and inclination of the deflecting surfaces we can arrange to distribute these three-quarters of the sound in increasing amounts toward the rear of the auditorium, and in this way artificially counteract the tendency of the sound to become fainter with increased distance from the speaker. As the amount lost by each impact is practically negligible, we can, if we wish, allow the sound to strike several times before it is finally deflected to the hearer. There are, therefore, several satisfactory arrangements of the deflecting surfaces according to the number of deflections allowed, and it is almost always possible to find an arrangement which corresponds to the architectural treatment desired. This procedure furnishes an absolute solution of the problem of *loudness*. It necessitates a certain amount of patience and care, but involves no insurmountable difficulties and no more complicated mathematical calculations than the measurement of the distances of sound travel and the angles of incidence and deflection. At the same time it is to a certain extent limited by conditions of distinctness which have not yet been considered. They are best explained by a simple diagram.

In Fig. 2, S is again the speaker, X Y Z the sound-wave, P and Q two small parts of the wave, and V W the wall of the auditorium. Now suppose that the sound P strikes the wall at R and is deflected back with slightly diminished intensity in the direction R A. We know that the angle P R W is equal to the angle A R V and that these two angles are in a plane perpendicular to the wall V W.

Now many other parts of the sound-wave are also moving in this same plane. If Q happens to be one of these parts, then eventually the crooked path of the sound P will cross the straight path of the sound Q at a point which is indicated by A. A person listening at A will, therefore, hear both sounds, first the sound Q, which has come by the short straight path S Q A, and subsequently the sound P, which has come by the longer crooked path S P R A. It has already been mentioned that the shortest perceptible space of time is about $\frac{1}{15}$ of a second. If the sound P reaches the listener less than $\frac{1}{15}$ of a second after the sound Q, he will merely perceive a single sound somewhat louder than either P or Q. On the other hand, if P reaches the listener more than $\frac{1}{15}$ of a second after Q, he will hear two distinct sounds. Finally, if P reaches the listener at exactly $\frac{1}{15}$ of a second after Q, he will merely be aware of indistinctness or confusion in the sound.

It is not difficult to determine which one of these three conditions actually exists in a given case: for we know that $\frac{1}{15}$ of a second of time corresponds to 80 feet of sound travel. All that is necessary is to determine by



measurement whether one of the two sound paths is 80 feet longer than the other. In practice it is not safe to allow a difference of over 70 feet. Whenever the discrepancy exceeds this amount it is desirable to change the inclination of the deflecting surfaces so as to throw the sound farther away from the speaker. If such a change is impossible the only recourse is to cover the deflecting surfaces with sound-absorbing material, but this procedure is unfortunate, as it wastes perfectly good sound which might otherwise be utilized where extra loudness is needed.

It does not make any serious difference whether the sound is reinforced from a side wall, from the floor or from the ceiling. On the other hand, the case of the wall opposite the speaker, that is of the wall at the back of the audience, is quite different. A sound deflected from this wall is almost sure to produce unfavorable results. The reason is easily seen. In Fig. 3, S R A is such a sound deflected from the wall behind the listener at A. This sound returning directly, or almost directly, toward the speaker, meets subsequent sounds of the speaker's voice moving in the opposite direction S T, in what might be called a head-on collision. The result is a confusion called sound-interference, the exact effects of which depend upon the volume and pitch of the conflicting sounds, and upon other conditions practically impossible to determine. The easiest solution of the difficulty is to avoid it altogether by destroying the deflected sound. This can usually be done either by covering the rear wall with sound-absorbing material, or by curving or inclining it so that all sound will be deflected to some other absorbing surface before it can reach the audience. It is worth noting, in this connection, that sound casts a shadow exactly like light, and that there is no need of applying sound-absorbing material to the rear wall at points where it is in sound shadow.

The case of the wall behind the speaker is very similar, but as there is no part of the audience between this wall and the speaker there is no need of sound-absorbing material. On the contrary, so considerable a part of the sound will always be deflected to the audience in spite of interference, that this wall may be included with the side walls for purposes of sound reinforcement.

It is evident that between cases of extreme sound-interference and others of almost perfect combination there must be numerous intermediate conditions of partial interference. In point of fact the whole interior of any auditorium is full of sound eddies varying constantly with the pitch and volume of the component tones. The writer knows no practical way of determining these conditions in advance, but his experience has been that if the serious difficulties arising from the rear wall are avoided the others may be neglected without noticeable inconvenience.

The foregoing analysis indicates that the conditions of distinctness are two. First, no two sounds must reach the same point by paths one of which is over 70 feet longer than the other. Second, no sound must be deflected from the rear wall into the audience. Within the limits of these conditions sound may be deflected to any part of the auditorium in such a way as to reinforce the direct sound and thereby produce the requisite loudness.

The third essential of acoustic success is no less tangible than the other two, but it is of a somewhat more complex nature. To trace in detail the connection between architectural construction and quality of tone would involve the mathematics of musical pitch and harmony, and a description of the more important musical instruments, together with the theoretic principles involved in the construction of each. Such a discussion would not be altogether foreign to the question of architectural acoustics, but it would lead us very far afield, besides duplicating much that is contained in all the standard text-books. For present purposes, therefore, we will merely state that the influence of architectural surroundings upon quality of tone is mainly dependent upon two factors, resonance and reverberation. Resonance is prolongation of tone produced by continuous vibration of elastic materials. Reverberation is prolongation produced by repeated deflection of sound from walls, floor and ceiling. These two phenomena, although at times resulting in similar acoustic effects, are fundamentally different in character, and require different architectural treatments. They will, therefore, be considered separately and in some detail.

Resonance occurs wherever vibration is transferred from one material to another, either by direct contact or through the air. When the two materials are in contact the second material will respond to all vibrations of the first, and the result is usually a very great increase in the volume of sound produced. A vibrating piano-string would of itself emit a very feeble tone because it is so slender that it can affect only a small volume of air. Supported on a sounding board by means of a fret it forces the board to vibrate at the same rate as itself or, in other words, to give out a tone of the same pitch, and as the surface of the board is large and can affect a considerable volume of air, the resulting tone is full and strong. Extend the process by placing the piano on a wooden floor and the same vibration will be communicated to the floor with the effect of a still further increase in loudness.

When the two materials are not in contact and the vibration is transferred from one to the other through the air, the second material will respond only to vibrations with which it happens to be in sympathy. In this case there is no real increase in loudness, the vibration being produced at the expense of sound which would otherwise be deflected. The greater the vibration the less the deflected sound. A wainscot near but not in contact with a piano will respond only to tones of a certain pitch. The floor of an orchestra-pit will respond only to a part of the notes emitted by the violins and other instruments which do not rest upon the floor. Under these circumstances a series of notes of varying pitch are apt to lack uniformity of both loudness and resonance. The notes to which the woodwork responds will be more prolonged and less loud. Those to which the woodwork does not respond will be less prolonged and more loud. It is evidently essential for the sake of both quality and uniformity of tone that floors and wainscoting should be so constructed as to vibrate in sympathy with tones of every pitch; and the same is true to a greater or less extent of all other vibrating materials in an auditorium. Some apparently successful attempts in this direction will be fully described in Part II. Plaster and masonry

walls and ceilings do not respond to *interior sound* sufficiently to produce a marked effect, but plaster on wire lath will sometimes resound to *exterior shock* in an extremely unexpected and disconcerting manner. This difficulty will be considered in connection with sound-proofing.

Several considerations must be taken into account in estimating the resonance in a given case. The mere introduction of large amounts of vibratory material does not of necessity involve a corresponding increase in resonance: for if the material be not so placed as to be largely exposed to direct impact of sound, very little vibration may be developed. In point of fact, ordinary wainscoting is naturally rather badly placed in this respect because the lower portions are shielded by the audience. A wainscot on the rear wall is apt to be entirely in sound shadow, and two or three deflections from adjacent ceilings must usually be contrived in order to direct any considerable volume of sound upon it. This is particularly true on the balconies; and, as will be explained in Part II, it is occasionally necessary to take some chances of indistinctness in order to obtain sufficient vibration.

As resonance is produced at the expense of deflected sound, it might appear desirable to exercise care in the use of wainscoting so as to avoid too great a diminution in the volume of deflected sound. In point of fact, however, there is no danger of any great loss in loudness on this account. The reason is that sound deflected from the upper part of a wainscot *never reaches the audience*, and consequently its loss is not perceived. It sweeps over their heads to the back of the auditorium and if not there destroyed returns in a plague of interference. On the contrary, the *vibration left behind in the wainscot continues to be heard* by the audience, and augments the volume of sound *actually heard*. For similar reasons, but to a less extent, an increase in total volume of sound is produced by constructing the floor of an orchestra-pit so as to act as a sounding board. The vibratory materials in an auditorium should be carefully distributed with reference to their proximity to the audience. A great deal of wainscoting concentrated at one point will not greatly enhance the resonance elsewhere. Much judgment and ingenuity are often necessary in order to make the decorative scheme meet the acoustic requirements, but so essential is a maximum of resonance in all parts of an auditorium that too much attention cannot be paid to the design, location and exposure of all vibratory surfaces.

On the other hand, reverberation, while frequently agreeable, is always an element of danger. At its best it produces an effect somewhat similar to true resonance; at its worst it degenerates into sound-confusion and echo. In a small room the result is pleasing when the reverberation is not excessive. In such a case, with deflections numbering some eighty or more a second, the average loss of sound per impact depends wholly upon the relative amounts of sound-absorbing materials. It makes no perceptible difference where the speaker or musician is placed or how the furniture is arranged: the reverberation will continue the same so long as the walls and contents of the room remain unchanged. Knowing the average distance of sound travel and the exact absorbing capacity of each of the materials to be used, it becomes a purely mathematical task to determine an average absorbing capacity which will give any desired prolongation of sound. The problem has been fully investigated by Professor Sabine, who has found by practical experiment that a reverberation lasting 1.1 seconds gives the most pleasing effect in an ordinary sized music-room. There is no occasion for duplicating here the theory and method of calculation, which are fully developed in the treatise already so frequently cited.

The larger the room the longer will be the average distance of sound travel, and the longer the reverberation for any given capacity of sound absorption. By the time we reach a room whose dimensions average 40 or 50 feet, the calculation begins to be complicated by factors other than mere size and absorbing capacity. The shape of the room and the location of the principal absorbing materials begin to have an appreciable effect, and the position of the speaker assumes an importance. Suppose a hall so arranged that no sound is deflected more than three times before reaching the audience, a condition by no means impossible. In such a case, if the walls absorb two per cent per impact, and the audience ninety-four per cent, there will remain after striking the audience less than six per cent of the original sound — an average loss of more than fifty per cent per impact. But now suppose that a dome is added and that the walls are curved so that each sound averages seven deflections before reaching the audience. There will still remain over five per cent of the sound, or approximately as much as in the first case, but the average loss per impact is only about thirty per cent. Evidently in the second case the reverberation will last much longer than in the first case, although the exact amounts of absorbing material in the room are unchanged. Again, suppose that the dome is so small as to occupy only a portion of the ceiling. In this case all sounds except those rising into the dome will be practically destroyed in four impacts, or perhaps $\frac{1}{10}$ of a second, but the sound in the dome may not wander back to earth until after an entire second of repeated deflections, producing a distinct and annoying echo.

Where the architect is called upon to remedy existing defects, the cause of the difficulty may usually be diagnosed and the remedy ascertained by such considerations as have just been enumerated: for in this case the results are all in actual evidence, and only known conditions must be met. Where, on the contrary, the architect is called upon to design a new auditorium, he must foresee every possible contingency, and the chances of missing some small but vital factor become almost overwhelming. With a seating capacity of upwards of a thousand, involving the separate consideration of nearly every auditor, the successful use of reverberation becomes too laborious for practical employment, and the only escape from the dilemma is to rely altogether upon resonance for quality of tone. If the suggestions concerning loudness and distinctness have already been carried out, the greater part of every sound-wave will have been already utilized to practical advantage, and it merely remains to destroy the remnants by proper application of sound-absorbing material.

Of course perfection is not in humanity, and it is not possible to eradicate every vestige of undesirable deflection, but so far can this procedure be carried as to give

the resulting tone a disagreeably lifeless quality. To offset this deficiency it is desirable to develop true resonance to the utmost by means of vibratory material, such as wainscoting and woodwork in general. *Resonance is never too accentuated where all possible reverberation has been eliminated*, and the amount of properly designed wainscoting, fixture work and other vibratory materials which may be introduced by the architect, is limited only by the decorative treatment of the auditorium and the length of the owner's purse. The acoustic effect resembles the humming accompaniment to a college glee, and is never so loud as to endanger the distinctness of the speaker's utterance. An auditorium designed for a maximum of resonance and a minimum of reverberation will combine the quality of tone necessary for music and the distinctness necessary for speaking: it will be equally well adapted to the production of both opera and drama — often an indispensable requirement.

The reader will have noted that in the preceding discussion there has been no mention of one very important vibrating material, namely, the air itself. As everyone knows, a column of air under certain conditions, as in an organ pipe, may produce a musical tone of tremendous volume. Such vibrating air columns exist to a slight extent in all auditoriums. They are conditioned by the relation between the distance of a given musical instrument from the wall and the pitch of the tone emitted. Obviously the pitch is a variable quantity, whereas the distance of the instrument from the wall is usually fixed; at all events it cannot be altered to suit every change of pitch. Possibly these vibrating air columns should be considered in placing the different instruments in an orchestra-pit.

So far, we have considered the action of sound in the air alone. Its action in solids is exactly analogous. It spreads in a spherical wave until it reaches the surface of the solid, and then is partly absorbed into the adjacent material and partly deflected back again. In practice, the result is apt to be somewhat unexpected because the materials of a building exist in thin layers, such as walls and floors, which prevent the sound from spreading laterally, and therefore transfer it to great distances with surprisingly small loss in intensity. A tie-rod imbedded in concrete acts in exactly the same manner as a speaking tube. The sound-wave is prevented from spreading laterally, owing to the difference in the consistency of steel and concrete, and consequently travels from end to end of the rod with almost no diminution. If one end of the rod chances to be attached to a vibratory surface, such as plaster on wire lath, a jar at the other end of the rod may be so transferred to the plastering as to result in a loud and prolonged sound. The same is of course true of steel girders and columns and of any other elastic material in similar shapes. A shock originating on the outside of a building may in this way be transferred in formidable proportions to the interior. The proper means of preventing the passage of sound is evidently to interpose successive layers of materials of different consistencies, taking care that no elastic material connects the different layers. A series of air spaces, separated by independent walls or partitions, approximates a theoretic sound-proofing, but care is necessary to prevent sound-communication from wall to wall through the floor girders or furring strips. Such an arrangement is open also to the objection that the air spaces themselves are liable to vibrate to tones with which they happen to be in sympathy. The writer has found by experience that a clear space of about 6 inches under the flooring of an orchestra-pit gives a maximum volume to tones of average pitch. Experiments conducted by Professor Sabine have shown that an air space 8 inches wide gives a maximum tone for the pitch of middle C. Probably this width corresponding to maximum tone has some mathematical relation to the length of the sound-wave, and would vary with the pitch. In the absence of complete data on this point, it would appear desirable to keep the air spaces either as shallow as possible or over 16 inches deep, avoiding spaces about 6 inches deep as likely to prove sonorous. The exact construction in one particularly difficult case will be fully described in Part II.

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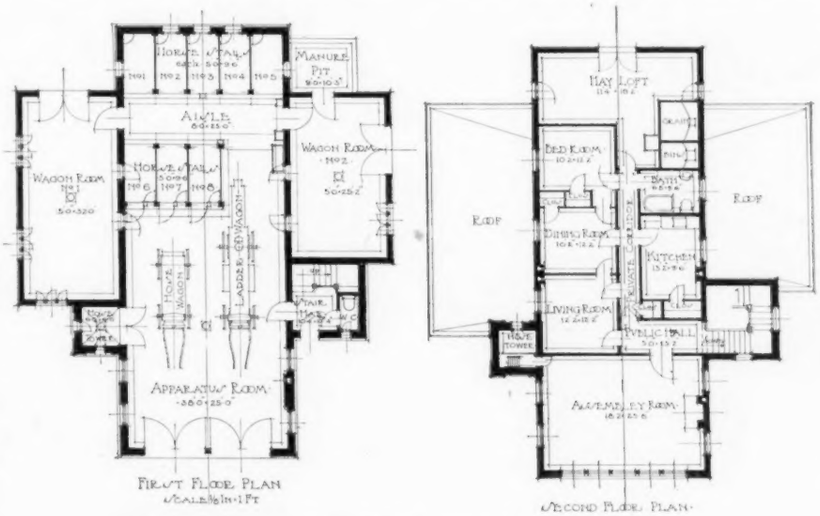
Fire Department Buildings.

BY HALSEY WAINWRIGHT PARKER.

THE architecture of a municipal or civic building, especially if it is in a city of considerable population, tends towards formality rather than picturesqueness in design, and naturally becomes somewhat monumental in its character. Economy of space, ease of circulation, simplicity of arrangement, are all essential and produce symmetry of plan, uniformity of treatment, and directness of expression—all of which are factors in monumental design. The development of the details of buildings of this character entirely dependsupon the number of different demands made upon the buildings and the comparative complexity of its requirements. The fewer requirements to be satisfied the less the possibilities of picturesqueness. In fact picturesqueness is the accident of consecutive growth, and becomes affectation if deliberately invented. And in addition to this, civic buildings, unless entirely isolated from all except ample natural surroundings, need to have sufficiently dignified character to be distinctive and to prevent their being overpowered by their adjacent neighbors. For all these reasons it can reasonably be assumed that civic buildings should have simple and monumental character rather than elaborated and aggressively unique design.



FIRE DEPARTMENT BUILDING AND TOWN HALL, WYOMING, OHIO.
Garber & Woodward, Architects.

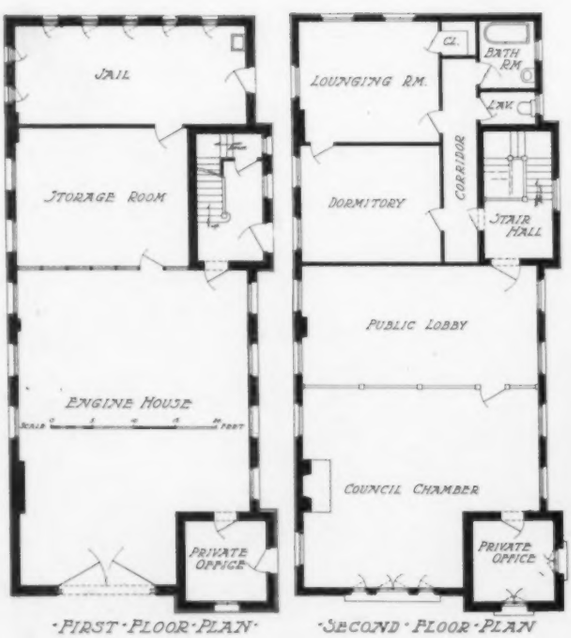
Of the many types which belong to this class, the one having the most definitely organized and in many respects the simplest plan is that of the Fire Department Station. Its factors are few, and are, room for the apparatus with ample and direct access to the street, if horses are used — stables adjacent to the engine house; dormitories for the men directly over the apparatus room; a recreation or lounging room for the men, and a hose tower. Additional factors are secondary. The result is a cubical, a building which does not turn corners in its plan, and usually does not exceed two or at the utmost three stories in height. This is exactly the type of building which is extremely interesting to an architect, as its purpose is readily expressed and it has not excessive height for the width of its façade. Also it has or can have an adequate amount of wall surface, without excess of openings and voids, and with the openings easily and naturally placed in good relations to each other.

With the exception of the main doorways there is nothing to absolutely fix the size, shape or position of openings, excepting the fact that adequate light should be provided, and this can be easily obtained. There are few if any complications caused by the adjustment over or around each other of rooms of very different areas and heights. The main entrances are capable of being made excellent in proportion and treatment, and in many cases an opportunity occurs which is rarely offered in other buildings — that of a tower which is not only of use but is necessary, and is not an addition for the sake of fantasy only, and a tower which requires few if any openings in its walls. These are ideal requirements, seldom presented in architectural design, and yet despite this fact, there has been no type of civic building so neglected, so wretchedly designed, and so feebly expressed as the Fire Department Building. It is not difficult to determine the apparent reason for this neglect. The problem was essentially one of utility. The location of the buildings was not of especial importance, the chief essential being that they should be in convenient places for efficient service. No care was given to anything more than the utilitarian problem, and in most cases little care to that.

That the Fire Department Building should serve its district, house its force, and be built with economy, was, and often is, deemed sufficient. But it has been proved time and time again that buildings to which little thought has been given have thoroughly expressed that unfortunate fact. The class of architects, fortunately becoming gradually less, to whom any piece of work was merely an opportunity to erect an unconsidered structure, were for years employed on these buildings, if in fact any architect was employed. The conditions are changing — there is appearing a certain pride taken in the quality of even the minor buildings erected by a municipality. City officials are beginning to exercise discriminative choice, recognizing the fact that good work redounds to their credit, and as a result

FIRST FLOOR PLAN SECOND FLOOR PLAN

FIRE DEPARTMENT BUILDING, EAST ORANGE, N. J.
Walker & Hazzard, Architects.



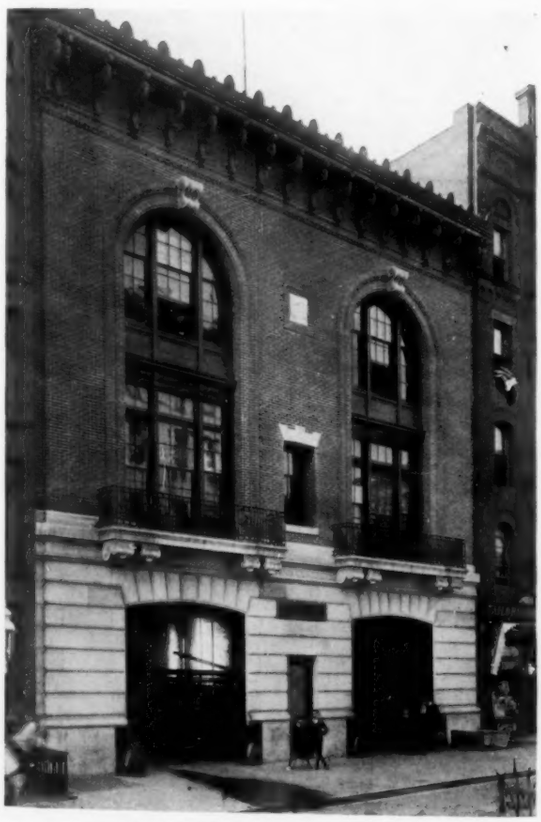
FIRST FLOOR PLAN SECOND FLOOR PLAN

FIRE DEPARTMENT BUILDING AND TOWN HALL,
LOCKLAND, OHIO.
Garber & Woodward, Architects.

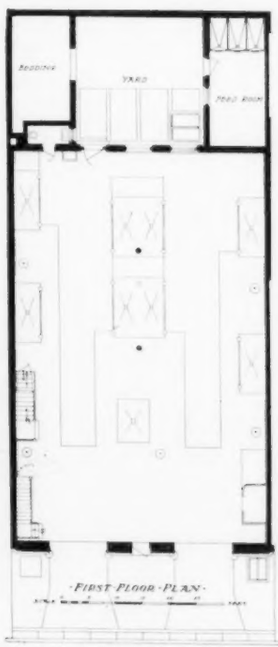
FIRST FLOOR PLAN.

SECOND FLOOR PLAN.

ENGINE HOUSE, BROOKLYN, N. Y.
Adams & Warren, Architects.



ENGINE HOUSE, NEW YORK CITY.
Percy Griffin, Architect.



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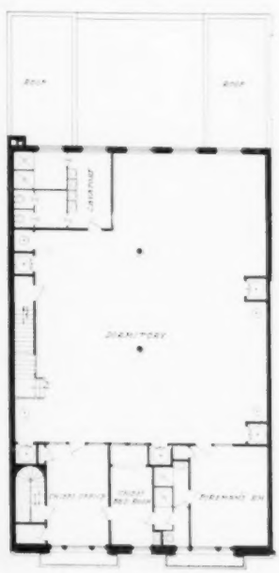

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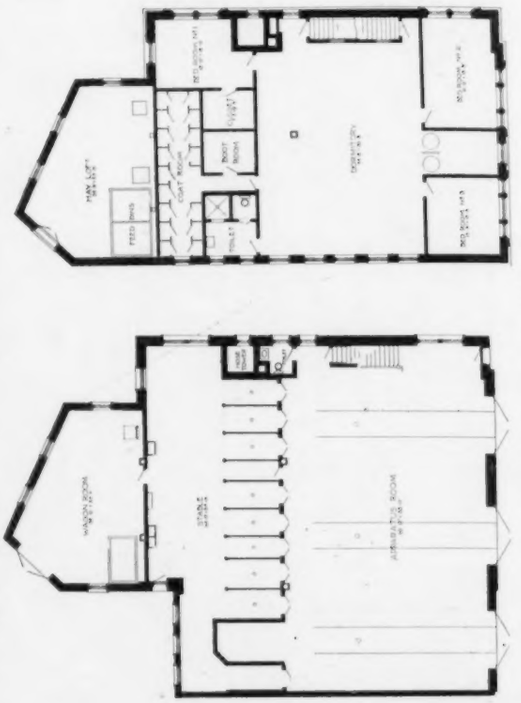
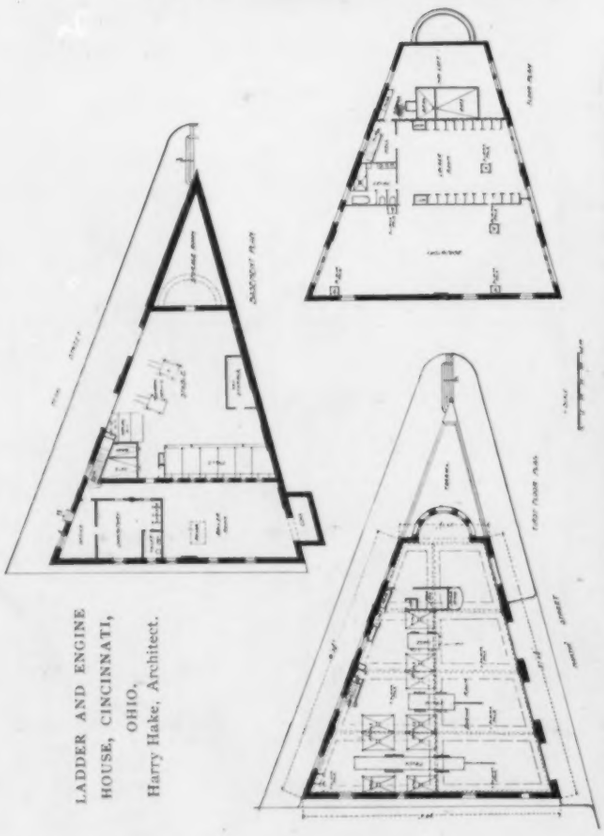
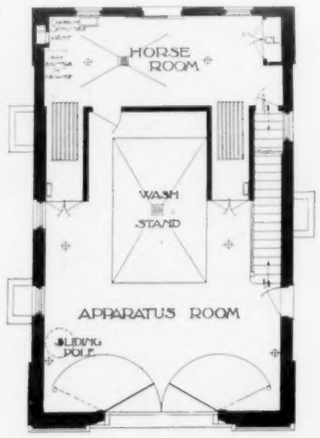


ENGINE HOUSE, SYRACUSE, N. Y.
Gaggin & Gaggin, Architects.

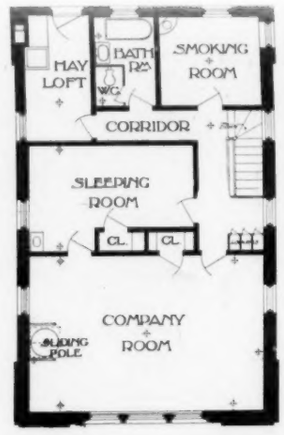


LADDER AND ENGINE HOUSE, CINCINNATI, OHIO.
Harry Hake, Architect.



'FIRST FLOOR PLAN'

ENGINE HOUSE,
BEVERLY,
MASS.
Kilham & Hopkins,
Architects.



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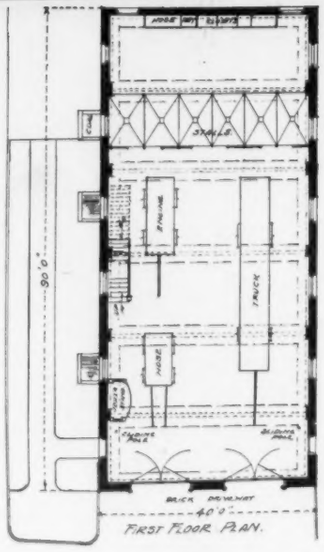
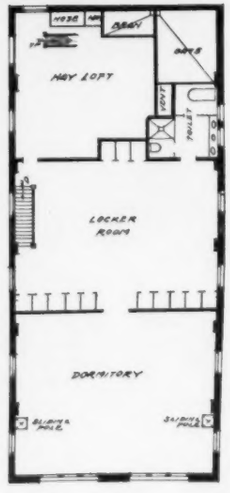


ENGINE HOUSE,
CINCINNATI,
OHIO.
Harry Hake,
Architect.



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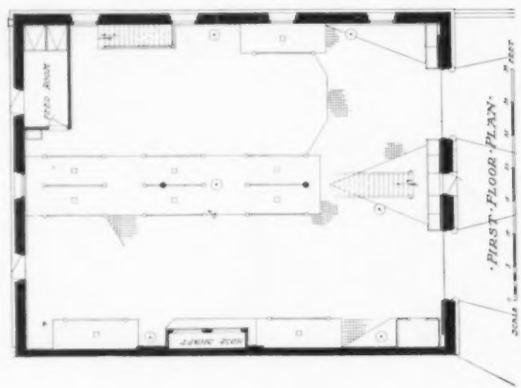
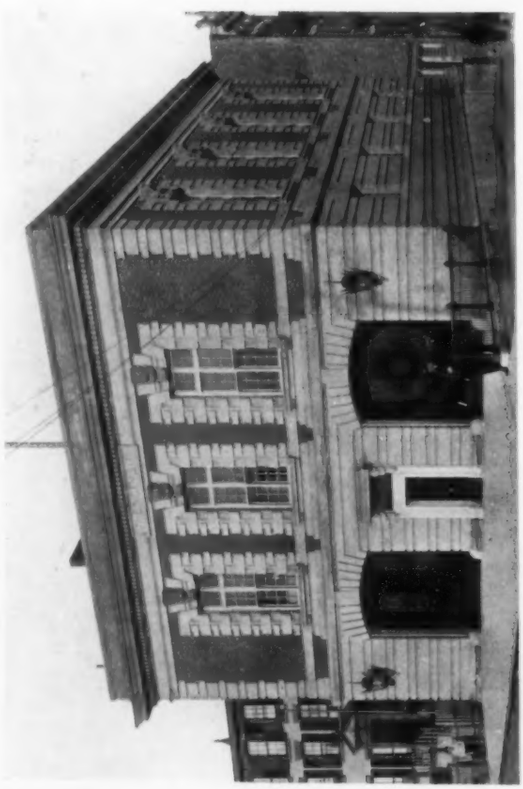
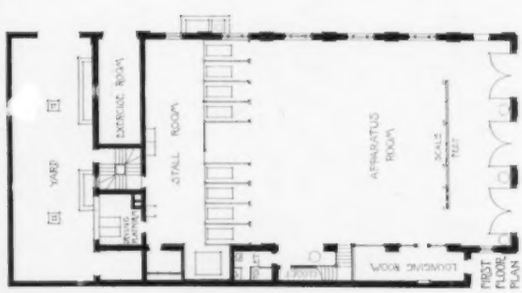


FIRST FLOOR PLAN.

ENGINE HOUSE, NEW YORK CITY.
Edward Pearce Casey, Architect.





CENTRAL FIRE STATION, CHELSEA, MASS.
G. Henri Desmond, Architect.

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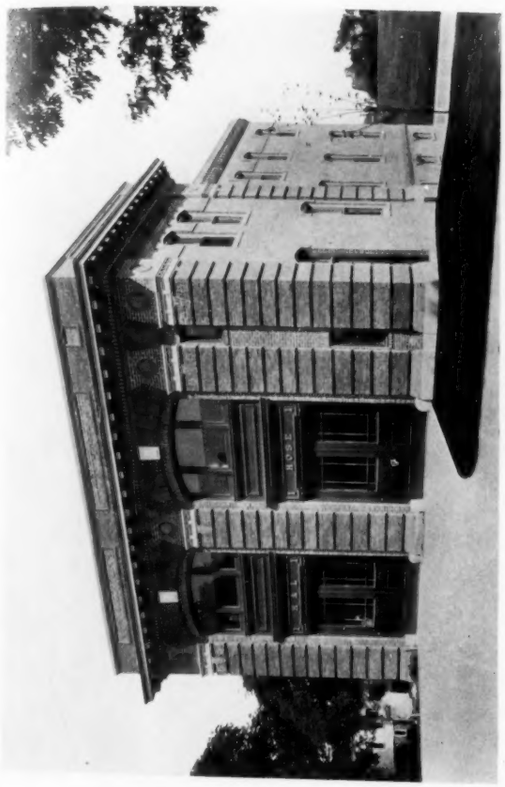
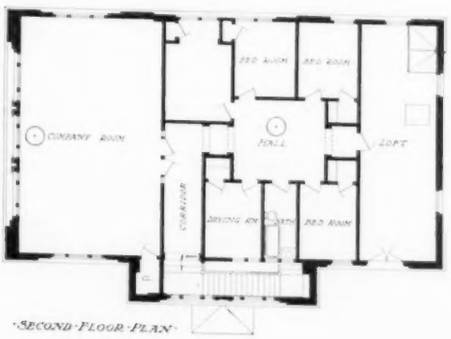


FIRE DEPARTMENT BUILDING, NORWOOD, MASS.
Allen & Collens, Architects.



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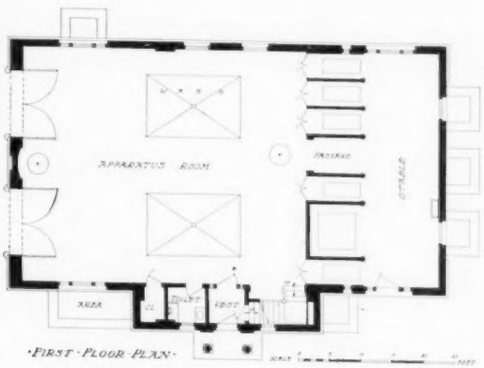
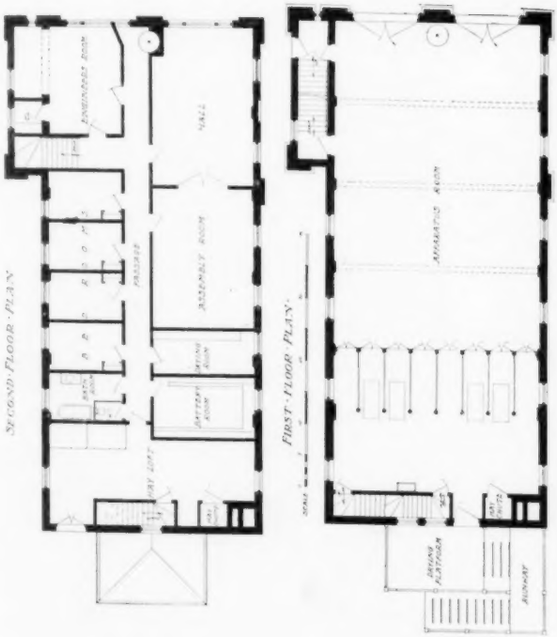
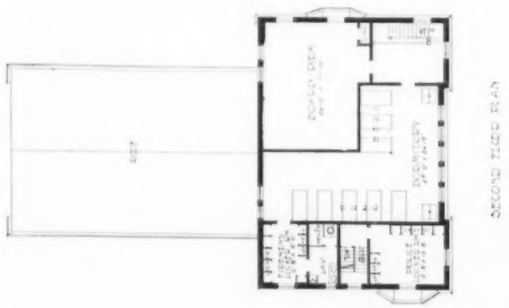
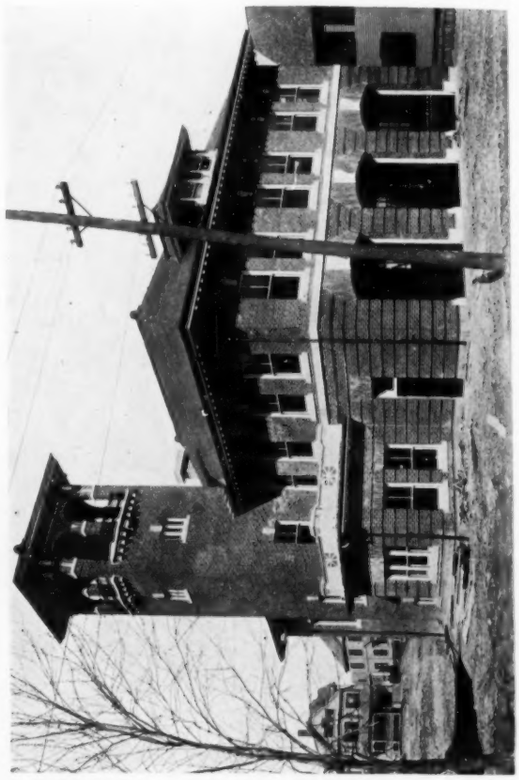


FIRST FLOOR PLAN.

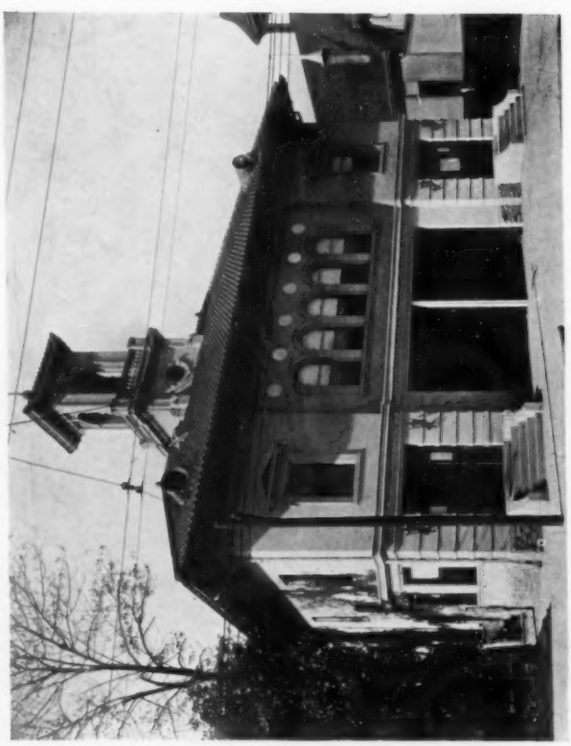
FIRE DEPARTMENT BUILDING, NORTH BEVERLY, MASS.
Cooper & Bailey, Architects.





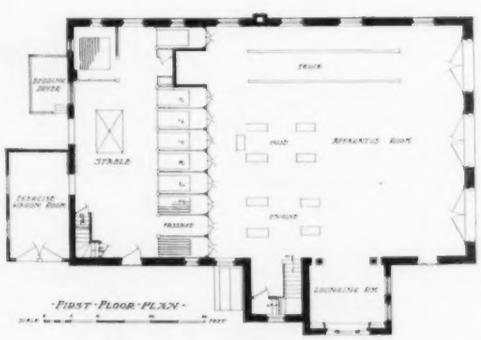


FIRE DEPARTMENT BUILDING, REVERE, MASS.
Penn Varney, Architect.



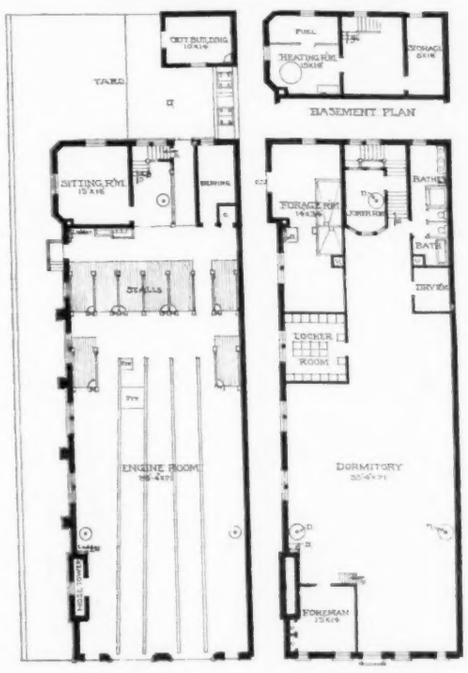
FIRE AND POLICE STATION, NORWOOD, OHIO.
Rapp, Zettel & Rapp, Architects

SECOND FLOOR PLAN



FIRST FLOOR PLAN

n parts of the country where Fire Department Buildings re necessary, they are receiving a certain amount of ttention, as the illustrations accompanying this article testify. But the field is still neglected, and there seems even to be disregard for conditions in some of the designs which are here presented.



FIRE DEPARTMENT BUILDING, WASHINGTON, D. C.
Appleton P. Clark, Jr., Architect.

The present phase of architectural education is based upon a very sane and plausible premise, i.e., that all good architecture has and should express the conditions of its period and place, and that therefore modern architecture in order to have lasting merit should do the same. This is undeniable. But the resulting corollary is perfectly false and undesirable, i.e., that modern architecture, being modern, should resemble nothing which has antedated it. As a matter of fact, structure to-day has the same elements as in the past, those of vertical supports, and horizontal or arched spanning of voids. Stone and brick and wood are assembled as they have always been assembled, and iron alone has broadened its possibilities. Few new structural forms have occurred except in the minor details, which have been unduly exaggerated; and it is extremely doubtful if many will appear at any time. But from this erratic reasoning in relation to new conditions, most of which do not exist, there has arisen a series of the most uncouth forms, especially in parapet terminations, and in corbeling and brackets, which are apparent in the modern buildings. A desire to express in a new manner induces exaggeration in every factor, and it is plain that exaggeration is the keynote of the work of many of the younger men in American architecture. If power is desired, mass and scale are exaggerated — with a monumental forgetfulness that all power has restraint as a prominent factor. If detail is desired it is exaggerated with a fine unconsciousness that detail should accent, not oppress. If mass is desired its bulk is exaggerated with a naive ignorance that mass is relative to its environment and has no power of expression without comparison with other masses. As a result there is to be found in most modern buildings a disregard for their environment, a scale much too large for their mass, and detail that is crude, however well intentioned. Any designer who has gone through the process of designing first in two dimensions, and later in three dimensions, finds by experience a marked difference in the method of determining scale in the two processes. In designing in two dimensions the smallest detail sets the scale of the pattern; no matter how large the repeat, or how definite the spot, the work must be brought to the scale of the smallest details. In designing in three dimensions a marked change is manifest. The scale is set by the smallest geometric solid, unless that solid is so small that it becomes a part of a design in two dimensions rather than part of a design in three dimensions. That is to say, in the assembling of solids there are two methods of attack — either one solid becomes so preponderant in mass that all other solids become associated details of it — or there are a number of solids similar in their respective masses, even if different in form, in which case the smallest solid sets the scale and the larger solid must be detailed down to it. In the first case there is a dominant — in the second a harmony of solids. It is always much easier to design with a dominant than it is to group solids of similar bulk. The study of descriptive geometry in the architectural schools has as one of its purposes an appreciation of such problems. When the dominant mass is adopted, large and heavy details do not add to its power, but detract from it. When the associated solids are chosen, heavy and coarse detail is in too large a scale for the detailing of the smallest solid. Despite these well known facts the addition of incongruous solids appears constantly in otherwise creditable designs; for instance, small projecting rooms with circular ends, peculiar masses at the tops and corners of towers, and on parapets; and heavy handed detail is everywhere apparent.

American architecture has often been praised for its

virility. It may be suspected at times that when this compliment comes from France or Italy, or even from England, it is a transparent subterfuge caused by a lack of other virtues which could be extolled. As a matter of fact, virility is an aggressive virtue and by no means equal to restrained power. There is quite sufficient virility in Greek work and in Renaissance, and in Gothic; but that adjective is never the first which is applied to the masterpieces of the past. Much of American work has the virility which appears in the Palais de Justice at Brussels. There is actually a much more exact word for it, that of crudeness. The expectation of a decade ago, which seemed justifiable when it was considered that so many young men who had received architectural training were entering the profession, that American architecture would rapidly improve, has not been adequately realized. Perhaps it is too soon to criticize the lack of performance. Certainly, as a whole, the buildings of the country are better than they were, and planning especially has improved, but in much of the work there is existent at present a peculiar phase — that of making details much too large for the masses they are supposed to ornament. They overpower masses, disturb shadows, break up surfaces, destroy edges. The requirements of a building force upon the architect a relation of the plan to the size of a man. The one portion of the design in which the architect has an opportunity for imagination, for individuality, he treats as if the building were for Brobdignagians, and unloads upon it a collection of ordinary and often uncouth forms grown to an abnormal size; such as quoins which would strengthen huge façades, and projections, but which would disturb any wall, on thirty foot fronts. Keystones bulge and spread where no keystones are needed. Voussoirs are accented at the expense of the arch line, destroying it. Corbels and brackets which would hold up five stories occur under a copper gutter moulding. Minor structural factors oppress and overcome the main structural masses, and there is very little study of mouldings. What is the cause for this manifest lack in American architecture? There are several causes and they seem to have joined forces to produce crude work.

First, there is the fact that the schools do not teach detail adequately — that drawings are made to a small scale and that masses alone are indicated on the drawings — and incidentally that great stress is laid on shadows — which are after all, though important, a secondary consideration to solids and voids. As a natural result of this teaching, the architect, untrained in detail — except that he has drawn the capitals and entablatures of the orders — enlarges the detail upon a drawing of ⅛ of an inch to the foot exactly as if it were an enlarged photograph, and leaves it in that condition. He does not know how to adapt it to full size and can only learn by careful observation and experience. The argument is that if detail is well placed and looks well on the scale drawing it must look well if pentagraphically enlarged. Why not apply the same argument to sculpture and mural painting? Ask any sculptor if he has difficulty in getting the spirit of his small sketch into the figure of heroic size, and if he merely enlarges the small sketch by the aid of calipers.

ENGINE HOUSE, CINCINNATI, OHIO.
Harry Hake, Architect.

Yet this is exactly what the American architect appears to be doing, and as a result there is no work in the world so crudely, barbarously detailed as American work. The final reason for crude detail is the mistaken idea that big things are impressive, indicate strength and power, and show breadth of conception. But this is the case only when they are carefully and justly related to each other. A big nose is not considered desirable — huge ears invite invidious comparisons. The whole design must have well considered relation of all its parts. Excess in any direction tends towards monstrosity.

One of the most interesting features in the Fire Department Station is that of the hose tower, which is for the purpose of allowing the hose to dry before being coiled. It is identical in character with the bell tower of an Italian church — requiring only slits for light in its entire height, but demanding ample air at the top. It is in fact a plain square shaft with all its possibility for ornamental light and shade, etc., at the top. It is perfectly natural that it should resemble the Italian square towers, for it has similar requirements. It does not seem necessary to have such eccentricity develop at the top of this tower as is at times apparent in some designs.

It has been mentioned that Fire Department Buildings are of two or at most of three stories in height, and have considerable wall area. They are not, therefore, with cased steel piers, and there is no reason for grouping the windows of two stories into one as an expression of structure, and such a treatment dwarfs rather than enhances the building. The large entrance door openings are the most important factors in the façade, and the treatment around and above these openings affords admirable opportunity for interesting detail. These openings permit the use of arches, and in fact arched treatment of openings either throughout or at chosen points in no way

terfere with adequate light, as is so often the case in utilitarian buildings. The designs accompanying this article are from the best of the buildings erected recently. Advantage has been taken of the possibilities of the problem and the results are in some cases of exceptional merit. They indicate that it would be wise for municipalities to realize that Fire Department Buildings present possibilities which occur in but few civic buildings of small size, and that they can be made attractive and express an appreciation of civic care which should be apparent in all city work.

It is gratifying to note that Civic Improvement Societies, Improvement Leagues, etc., are increasing in every community, and that men qualified to advise are joining in the desire to better the type of buildings which are erected; but in most cases these societies are made up of private individuals, who have little to say in the actual allotment of work, and whose influence is one more of general education than of actual executive power. Without doubt their influence carries weight, but the officials of a city need to have object lessons at hand before they can learn to discriminate between good and mediocre work. It is not unusual to find the best public spirit amongst trained politicians, but the knowledge of admirable architecture is hardly to be expected in that quarter. This is in no sense derogatory to their good-will or intention, it is merely the acknowledgment of an existing condition, that is, that good taste in architecture is a sense acquired by study and not an accidental accomplishment. Therefore there is no more valuable means of education towards the erection of good buildings in the future than the careful study of similar buildings in the present, and the building of object lessons which may be compared by the public with the less studied buildings of the past. The Fire Department Building is in a sense a unique opportunity, being devoid of serious difficulties, and of a size and character which permit excellent results, and it will fully repay the study which may be devoted to it. That study has been thoroughly performed as far as the plan and utilitarian requirements are concerned, but the exteriors still leave something to be desired, and it is hoped that the problem will appeal to architects in the future more than it apparently has done in the past.

The following comprises a brief description of some of the buildings illustrated.

Hook and Ladder House, West 63d Street, New York City. Werner & Windolph, Architects. Plate 60. This building was designed to meet the conditions imposed by the increasing cost of land and construction, and with the further desire to concentrate a large amount of fire apparatus in a given locality. The plan consequently provides for the storage of from six to eight engines in the basement. These engines are raised to the first story by the means of a two deck electric elevator, the upper deck being at the first floor level. The apparatus on the first floor deck having left the building, the engines in the basement can be lifted to the first floor level in fifty-five seconds. The third floor of the building is used as a recreation room and gymnasium.

Engine House No. 5, Chelsea, Mass. G. Henri Desmond, Architect. Plate 59. On the second floor is a workshop for the men, where they may indulge themselves in handicraft hobbies. A large bell is hung in the upper part of the hose tower. The cost of the building was about $37,000.

Central Fire Station, Chelsea, Mass. G. Henri Desmond, Architect. Page 122. The cost of the building was approximately $45,000.

Hose House, Beverly, Mass. Kilham & Hopkins, Architects. Page 121. Plan for a one company house with provision made on the first floor for a spare piece of apparatus. The main doors are 12 feet wide. The building cost about $6,500.

Fire Department Building, Village of Wyoming, Ohio. Garber & Woodward, Architects. Page 117. The building provides for a volunteer fire department and the club room shown on the second floor is where the members hold monthly meetings and smokers, usually after a fire drill. The small wings are for the sprinkling carts, wagons, etc., which are owned by the Village. The second floor provides a chamber where the Village Council meets.

Engine House, East Orange, N. J. Walker & Hazzard, Architects. Page 118. The building cost $8,000 complete. The only unusual feature about the plan is that the stairs are placed in a projecting wing, leaving the floor space entirely clear.

Engine House, Norwood, Mass. Allen & Collens, Architects. Page 123. The problem in this case was to properly express the openings for the engine and hose wagon on the façade, together with an ample staircase to the second story, opening off the side street. This naturally did away with any attempt at the expression of an axis and the architects frankly threw the doorways off center, and so arranged the main piers as to include the staircase at the side. The second floor has a large meeting room for the volunteer corps. The total cost was $14,300.

Combination Engine and Truck House, Washington, D. C. Appleton P. Clark, Jr., Architect. Page 125. The exterior of the building is pebble-dash on brick. The roof is of red Spanish tile. The first floor of the interior is finished with painted brick walls. The cost of the building was about $25,000.

Fire Station, North Beverly, Mass. Cooper & Bailey, Architects. Page 123. The cost of the building was about $20,000. The basement provides accommodations for the drying racks, store rooms, company room, kitchen and toilet rooms.

Fire and Police Station, Norwood, Ohio. Rapp, Zettel & Rapp, Architects. Page 124. The building is of light gray brick with terra cotta trimmings. The total cost was $18,000.

Central Fire Station, Kalamazoo, Mich. F. D. Van Volkenburg, Architect. Plate 59. The stable, with walls of glazed brick, is entirely shut off from the remainder of the building with glass doors and transoms. The heating apparatus is placed under the front of the building away from the stable. The stall partitions are of 2 inch plank with rounded edges, 2 inches apart for ventilation. The cement floors in stalls are recessed 4 inches and sloped to cesspool, peat being used for bedding. The total cost of the building was $22,640.

Editorial Comment and Miscellany.

MR. PERKINS AND THE CHICAGO BOARD OF EDUCATION.

THE city of Chicago has lost the services of one of the few men in this country who has brought to bear upon the problems of school construction a mind professionally trained, and who by hard and intelligent work has made himself an expert on the subject. Dwight H. Perkins, a well-trained and experienced architect, has been removed from office through the influence of one who might fairly be classed as an amateur with political experience.

How long our people will take to learn the evils and dangers of governing through amateurs it is impossible to say. In this respect we are years behind every European country; but we are beginning to awake to an understanding of this matter, and every action such as this of the Board of Education of Chicago is one more nail in the coffin of government by amateurs. One may have at least this satisfaction in accepting such a situation.

Mr. Perkins held a position of great responsibility and of great difficulty, having the charge of the school buildings, their erection, care and maintenance. To put it briefly and in a popular way, this laid him open to the criticism of all who have children, of all who teach, of all who take care of the buildings, of all who build, and of all who make repairs. This is a fruitful field; nearly every one in a city comes in one or another of these classes and has cause at times to believe — sometimes with reason and sometimes not — that a particular part of the complex duties of the man in charge is not being well done.

Any man who fills such a position must expect unthinking criticism and be prepared patiently to convert his critic by helping him to understand — he must expect thoughtful criticism, based on wrong premises or lack of knowledge, and be prepared to meet this in the spirit in which it is meant — he must expect well-founded criticism, and be prepared to acknowledge himself wrong promptly and effectively — he must expect malicious criticism, and be prepared to be silent under it. If however he is conscious that he is giving professional service, the best that is in him, and knows that the work under his charge is growing, improving, going forward steadily, as the tide rises, he has a right to expect the support of those who are in the responsible positions, to expect that these will at least have sufficient intelligence to understand the difficulties, help to overcome them, to appreciate the good service and encourage it. Many of those who are most active in the criticism of public servants stand outside the arena and take no share in the fight. Others stand outside and do not take sufficient interest in the game even to criticize. The critics criticize these for staying outside, and then turn and rend first one side and then the other in the contest whose strife they are enjoying. It is little wonder that capable business men, men of affairs, professional men, are shy of that conspicuous field where they may hardly expect the support of those who ought to be fighting with them, and where they must submit to having their best efforts belittled, their errors magnified, and their motives and morals questioned.

In the present case it is perhaps impossible for one at a distance to know all the details, to know just what charges were made, the competency of those who made the charges or the accuracy of the charges made; even one on the spot can rarely get to the bottom of such matters and find out definitely whether or not some personal animus is behind it all. Of this however one can be sure, for it is a matter of record — under the administration of Mr. Perkins the intelligent study of school problems has advanced rapidly. Chicago's modern schools are in many respects models of their type for our large cities. There has been year by year, under Mr. Perkins, a steady improvement in planning and construction, and this is a great thing to say for a period of years that has been filled with unrest, uncertainty, new educational problems, new demands, hygienic and esthetic — all of which have modified school requirements and school plans. When to these various new requirements the personal element is introduced, a reasonable theory may quickly become a fad, and its supporters enthusiasts or fanatics. It is in the air, and each one of us knows the enthusiast, for open air, for industrial work, for vocational high schools, for popular use of assembly halls, for pictures, sculpture and color, for nurses and doctors, for feeding the anemic, for teaching the mothers. Divide these into all their variants and consider what the task is of the man who plans, builds, maintains, repairs or equips the schools for these manifold interests.

Mr. Perkins was doing this work and doing it well, and he was removed by a board composed of amateurs, of whom probably no one was competent to pass a judgment on Mr. Perkins' work. This board had ample opportunity to inform itself in regard to Mr. Perkins' competency. There is a small group of men who have had experience similar to that of Mr. Perkins, and extending over longer periods. Mr. Snyder in New York, Mr. Ittner of St. Louis, and Mr. Sturgis of Boston are known more or less throughout the country for their knowledge of school planning and construction. Any one of these men could have advised the board so that they might have acted with intelligence. In March Mr. Sturgis wrote the president of the Board of Education, and said in part:

"Those of us who have been studying critically and intelligently the construction and equipment of school buildings during the last ten or twelve years believe that there are four cities where the best, most constructive, and most thoughtful work is being done. This work has helped to establish standards elsewhere, and the steady growth of intelligent school building is largely due to the work of New York, St. Louis, Chicago, and Boston. To the work done in Chicago Mr. Mundie contributed very valuable thought, and his work has been intelligently carried on by Mr. Perkins, and I believe that a careful inquiry into the work done by Mr. Perkins, by those who are really competent to judge, would show that the city of Chicago has been receiving exceptionally good service from him."

Mr. Sturgis added ...t as a public serv... his services were ...their disposition.

The president of ... Board acknowl...ged the letter courteously, and proceeded to press his charges and secure the dismissal of Mr. Perkins.

The Western Architect stated that "the reading public of Chicago have found that their school board is headed by a president who has no artistic perception, no knowledge of the connection between architectural art and the moral or physical development of the pupil"—and they might have added, nor even common intelligence *The Western Architect's* summary of the mental equipment of the president of the board may be accurate, but that the reading public of Chicago have found it to be so is quite another matter. When the reading public of this great, but inconceivably careless country, does find out these things, they will stop. Until they find out, they will continue. The more flagrant the instances are, the more quickly they will find out. For this at least one may be grateful to men of the stamp of this president of the Board of Education; for such a man will open the eyes of the public. In the meanwhile it is Chicago, not Mr. Perkins, that suffers.

HOUSE AT COLUMBUS, OHIO.
Roofed with Ludowici-Celadon Company T-14 tile.
Frank L. Packard, Architect.

AT THE second annual meeting of the Pennsylvania State Association of Architects, held in Pittsburg recently, the following named officers were re-elected for the ensuing year: David Knickerbacker Boyd, president; Edward Stotz, vice-president; William L. Baily, secretary and treasurer.

The work accomplished by the association during the first year of its existence is highly gratifying, and it promises to become a vital factor in the interests of the profession throughout the state. Architects in the smaller states and towns are manifesting an interest and making application for membership.

The most important business of the session was the report concerning the proposed revision of the building laws of the city of Pittsburg. Through its president, Mr. Edward Stotz, the Pittsburg Chapter of the A.I.A. enlisted the coöperation of twelve of the most important organizations of the city of Pittsburg, who addressed a memorial to the mayor and councils, with the result that a commission was appointed to revise the building code. This effort will be followed by others, which will urge upon the smaller cities the necessity of a revision of their building laws.

DETAIL BY ROBERT C. BERLIN, ARCHITECT.
Northwestern Terra Cotta Company, Makers.

DETAIL BY FERRY & CLAS, ARCHITECTS.
Atlantic Terra Cotta Company, Makers.

IN GENERAL.

Russell E. Hart, formerly of New York City, and C. C. Motz, formerly of the firm of Howard, Motz & Co., Nashville, Tenn., have formed a copartnership for the practice of architecture, with offices at 227 Sixth avenue, North, Nashville. Manufacturers' samples and catalogues desired.

Ernest F. Guilbert and James O. Betelle have formed a copartnership for the practice of architecture under the firm name of Guilbert & Betelle, with offices at 25 West 32d street, New York, and 917 Broad street, Newark, N. J.

Gustave A. Niehus has opened an office for the practice of architecture at 25 Callahan Block, Dayton, Ohio. Manufacturers' catalogues desired.

Frank W. Cooksey and Fred B. Maxwell have associated for the practice of architecture under the firm name of Cooksey & Maxwell, with offices in the Forsyth Theater Building, Atlanta, Ga.

Arnold W. Brunner has removed his offices to 320 Fifth avenue, New York.

The partnership of Darrach & Beekman, architects, 10 East 33d street, New York, has been dissolved. Jas. M. A. Darrach

DETAIL BY G. AJELLO, ARCHITECT.
New York Architectural Terra Cotta Company, Makers.

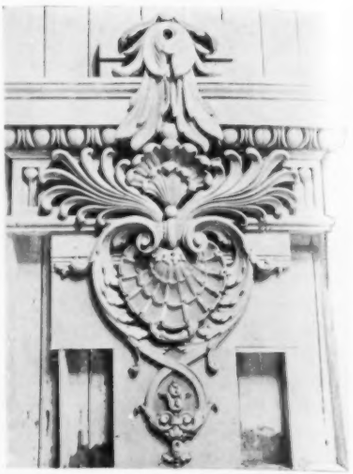
and William F. Beekman will continue the practice of architecture at the same address in their individual names.

John H. & Wilson C. Ely announce the removal of their offices to The Firemen's Building, Broad and Market streets, Newark, N. J.

Brick manufactured by the Pearl Clay Products Company of Bradford, Pa., were used in the following named buildings recently erected in New York City: St. Gabriel's School, John V. Van Pelt, architect; Apartment House, Schwartz & Gross, architects; Harpery Hall, Henry W. Wilkinson, architect; Club House, J. Riley Gordon, architect; Public School, C. B. J. Snyder, architect; Apartment House, Neville & Bagge, architects.

James E. Grunert, architect, has opened an office at 2010 Richmond road, New Dorp, N. Y. Manufacturers' catalogues and samples desired.

The "Peerless Arch" for fireproof floors, made of terra cotta blocks and reinforced with metal and cement, has been placed upon the market by Henry Maurer & Son, New York City. The demand for a combination fireproof floor for long spans between walls or between beams and girders is successfully met with this arch. This combination of materials forms a light and very strong floor arch. The thorough protection of both cement-concrete and metal with terra cotta provides a finished ceiling in which the cement joints do not show through the plastering. The arch can be used in every kind of structure — office buildings, residences, factories, warehouses, etc. The cost is low, owing to the simplicity of the method.



DETAIL BY KEES & COLBURN, ARCHITECTS.
American Terra Cotta Company, Makers.

The Atlantic Terra Cotta Company will furnish the architectural terra cotta for the following mentioned new buildings: Heidelberg Building, New York City, Henry Ives Cobb, architect; Vanderbilt Tenements, New York City, Henry Atterbury Smith, architect; — in these tenements a considerable amount of polychrome terra cotta will be used; Municipal Building, New York City, McKim, Mead & White, architects; Churchill's Restaurant, 49th street and Broadway, New York City, Robert Baer, architect; Nazimova Theater, New York City, Albert Swasey, architect; — this building will be of white mat glazed terra cotta from the water table up.

DETAIL BY WHEELER, GALLEHER & STERN, ARCHITECTS.
New Jersey Terra Cotta Company, Makers.

A panel executed in colored terra cotta has been placed in the pediment of the Parkhurst Church, Madison Square, New York, McKim, Mead & White, architects. The panel was designed by Harry Siddons Mowbray, and executed by Adolph A. Weinman. The work was furnished by the Atlantic Terra Cotta Company.

The Second Church of Christ, Scientist, Los Angeles, Cal., A. F. Rosenheim,

DETAIL BY MAURAN & RUSSELL, ARCHITECTS.
Winkle Terra Cotta Company, Makers.

DETAIL BY FRYE & CHESTERMAN, ARCHITECTS.
Brick, Terra Cotta & Tile Co., Makers.

architect, illustrated in THE BRICKBUILDER for April, was built in large part of Hydraulic-Press Brick.

F. B. Wheaton, who is the advisory architect for the United States War Department, was architect of the Drill Hall at Fort Des Moines, Iowa, illustrated in THE BRICKBUILDER for March of this year, and not J. Knox Taylor, as stated.

THE "WITCH DOCTOR," SCHOOL OF MEDICINE, UNIVERSITY OF PITTSBURG.
Atlantic Terra Cotta Company, Makers.
Palmer & Hornbostel, Architects.

The United States in 1908 turned out $108,062,207 worth of brick and tile manufactures. Every state and territory in the Union contributed to the totals, but Ohio led all others with products valued at $15,915,703 for the year.

The terra cotta for the Fire Station at Brookline, Freeman, Funk & Wilcox, architects, illustrated in this issue, was furnished by the Atlantic Terra Cotta Company.

NEW BOOKS.

MODERN LETTERING — Artistic and Practical — for architects, artists, decorators, etc. The construction of pen and ink designs for commercial uses, memorials, resolutions, etc. By William Heyny. Price $2. New York, William T. Comstock.

THE ESSENTIALS OF LETTERING — A manual for students and designers — by Thomas E. French and Robert Meiklejohn. Columbus, Ohio, Varsity Supply Company.

BRICKLAYING SYSTEM, by Frank B. Gilbreth. The purposes of this book, as enumerated by the author, are as follows: (*a*) To put in writing that knowledge which has been handed down by word of mouth from journeyman to apprentice for generations. (*b*) To record methods of handling labor, materials and plant on brickwork that will reduce costs and at the same time enable the first-class workman to receive higher pay. (*c*) To enable an apprentice to work intelligently from his first day, and to become a proficient workman in the shortest possible time. New York, The Myron C. Clark Publishing Company.

DETAIL BY FERRY & CLAS, ARCHITECTS.
Atlantic Terra Cotta Company, Makers.

TABLES FOR CALCULATING SIZES OF STEAM PIPES FOR LOW PRESSURE HEATING, by Isaac Chaimovitsch, M. E. Price $2. Chicago, Domestic Engineering.

THE SLIDE RULE — An elementary treatise by J. J. Clark. It has been the author's aim to produce a work that will enable anyone having a knowledge of the ordinary principles of arithmetic to use the Slide Rule readily and with precision, to understand thoroughly the principles governing its construction and operation and the reasons for all settings, and to familiarize the reader so thoroughly with the use of the instrument that he cannot forget how to use it and need not remember any of the settings. Scranton, Pa., Technical Supply Company.

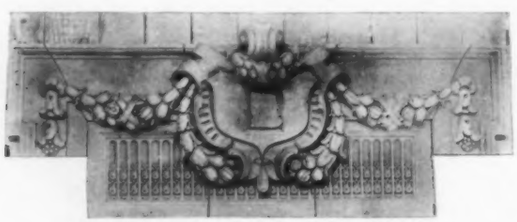
A HISTORY OF ARCHITECTURE, by Russell Sturgis, Vol. II., Romanesque and Oriental. The subject of Vol. II. differs from that of Vol. I. in that the buildings considered are generally in existence. The difficulty in the new inquiry is in the partial substitution for the original work of art, of a highly sophisticated modification of it, put into place by later workmen who were partly out of sympathy with the original designers.

DETAIL BY C. C. & A. L. THAYER, ARCHITECTS.
Conkling-Armstrong Terra Cotta Company, Makers.

DETAIL BY ROUSE & GOLDSTONE, ARCHITECTS.
South Amboy Terra Cotta Company, Makers.

FIREPLACE EXECUTED IN COLORED FAIENCE BY THE HARTFORD FAIENCE COMPANY.

LAWRENCE VEILLER in his book on Housing Reform, which has been published recently by Charities Publication Committee, 105 East 22d street, New York, says, "No housing evils are necessary. Prevention's the thing; the small cities the place; now the time.



DETAIL BY A. P. CLARK, JR., ARCHITECT.
Ketcham Terra Cotta Works, Makers.

The great opportunities to save the people from overcrowding lie in the smaller cities. Thirty years ago congestion was a live question in New York because it was manageable. While in some of the larger cities it now seems hopeless, it is not so in any city of 100,000."

"If I were to emphasize any particular line of affirmative action in housing reform it would be the prevention of the tenement disease before any city begins to suffer from it. New York has over 100,000 tenement houses; over 20,000 tenements in which most of the rooms are without light or ventilation; over 80,000 buildings a standing menace from fire; over 1,000,000 people without bathing facilities in their homes."

FRANKLIN BUILDING, SEATTLE, WASH.
Walls of white enamel brick with terra cotta trim. Brick furnished by the American Enameled Brick & Tile Co.

"SPECIFICATION BLANKS," by T. Robert Wieger, architect (formerly with F. E. Kidder). Forms for all classes of buildings, each trade separate. Complete set, 44 pages, 25 cents. Reduction on quantities. Sample page upon request. 628-14th street, Denver, Colo.

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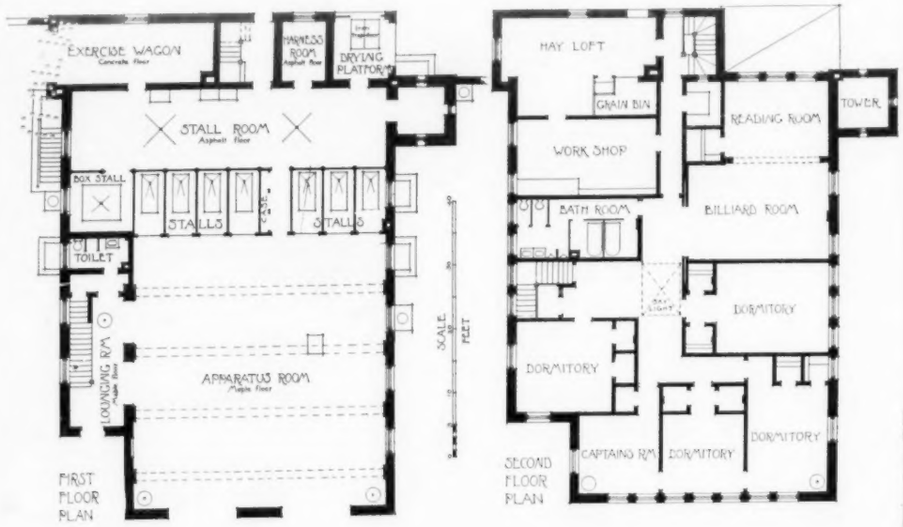

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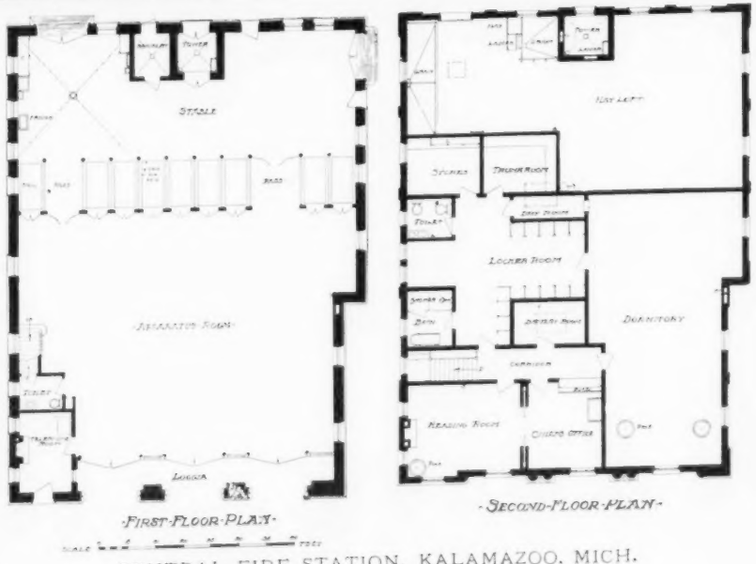

CENTRAL FIRE STATION, KALAMAZOO, MICH.
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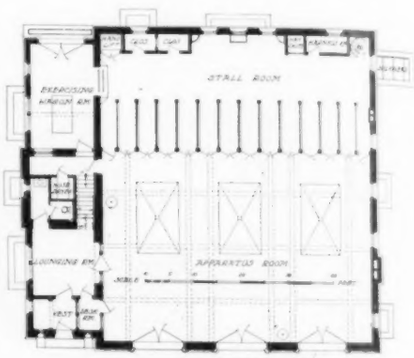

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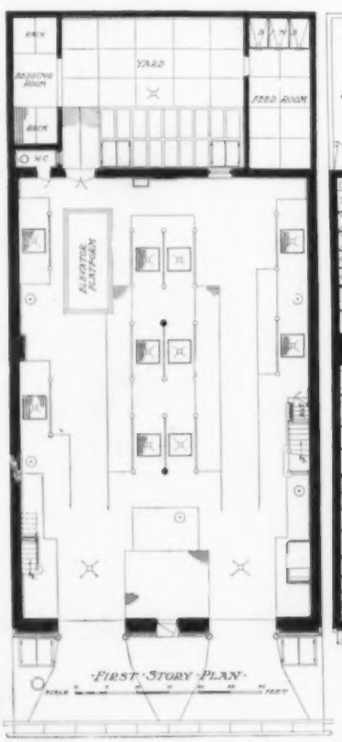

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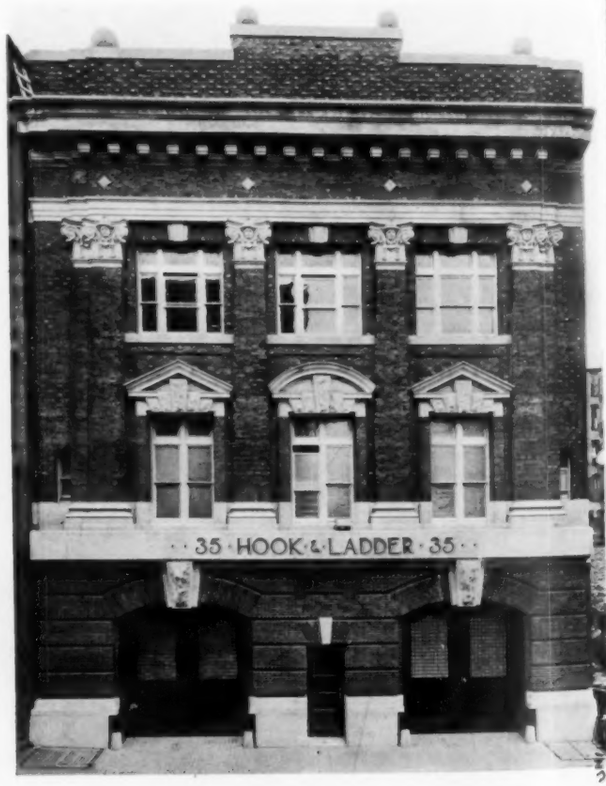

HOOK AND LADDER HOUSE, NEW YORK CITY.
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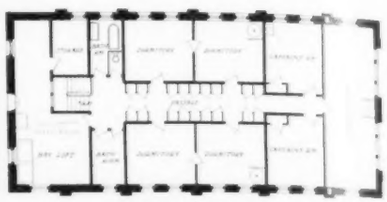

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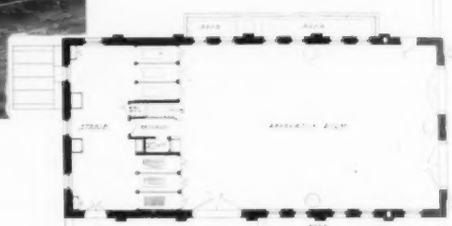

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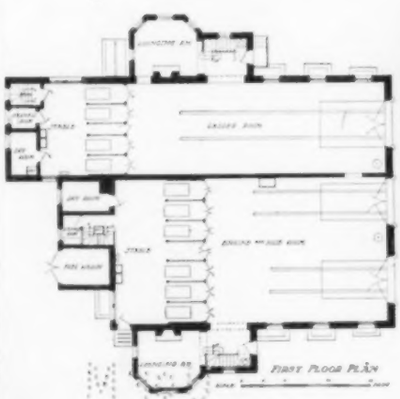

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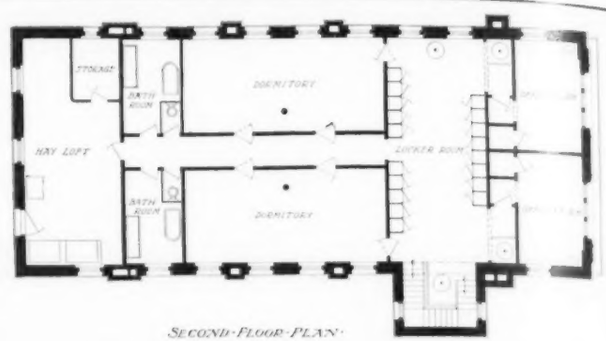

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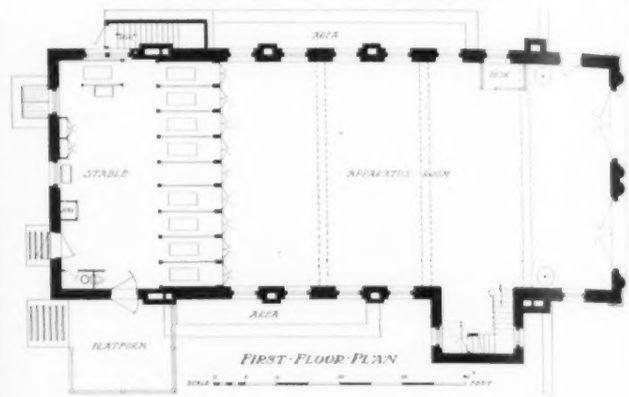

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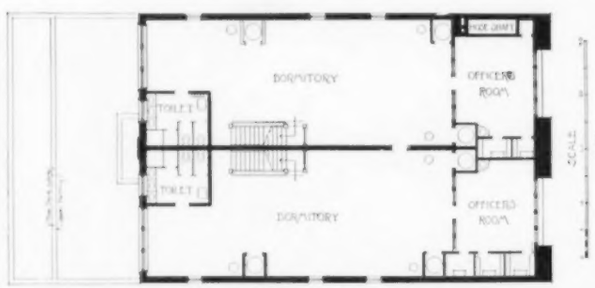

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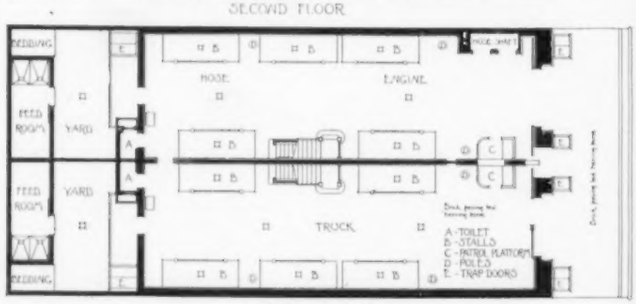

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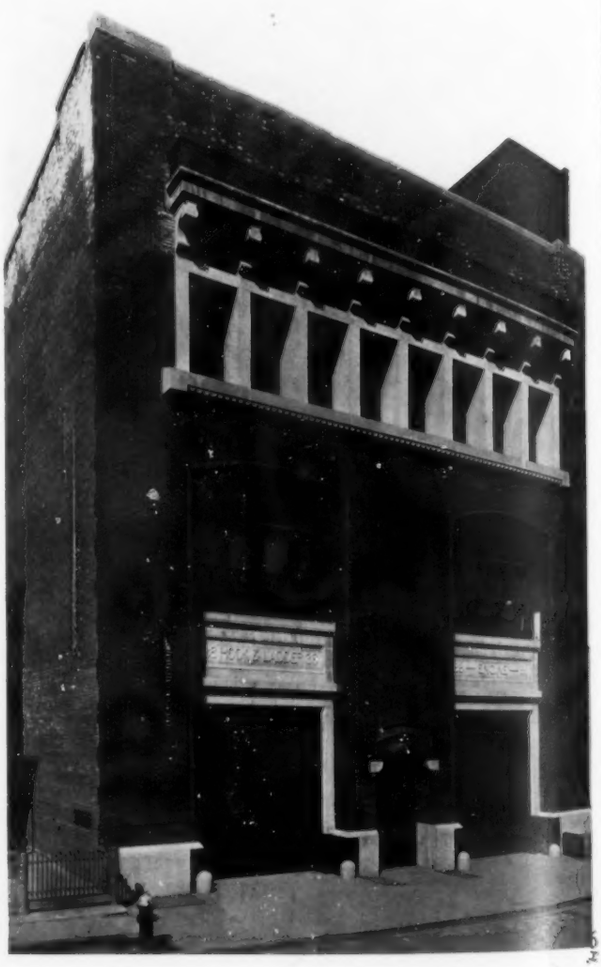

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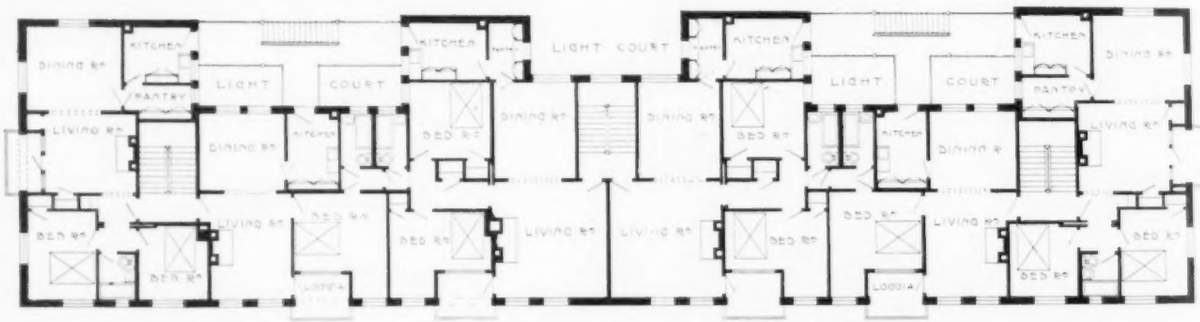
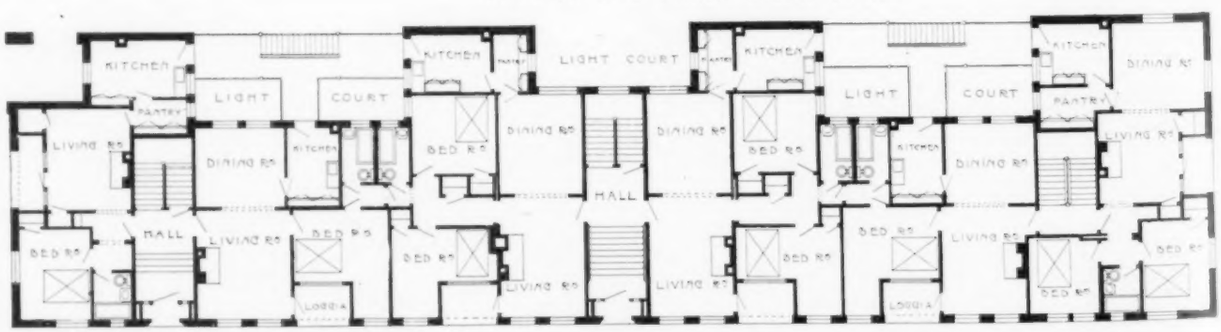


SECOND AND THIRD FLOOR PLANS



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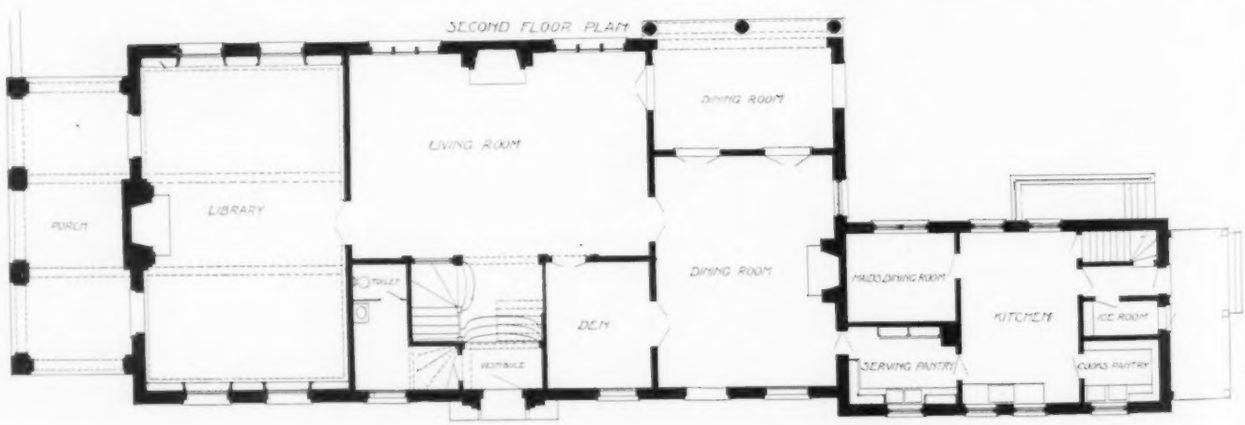

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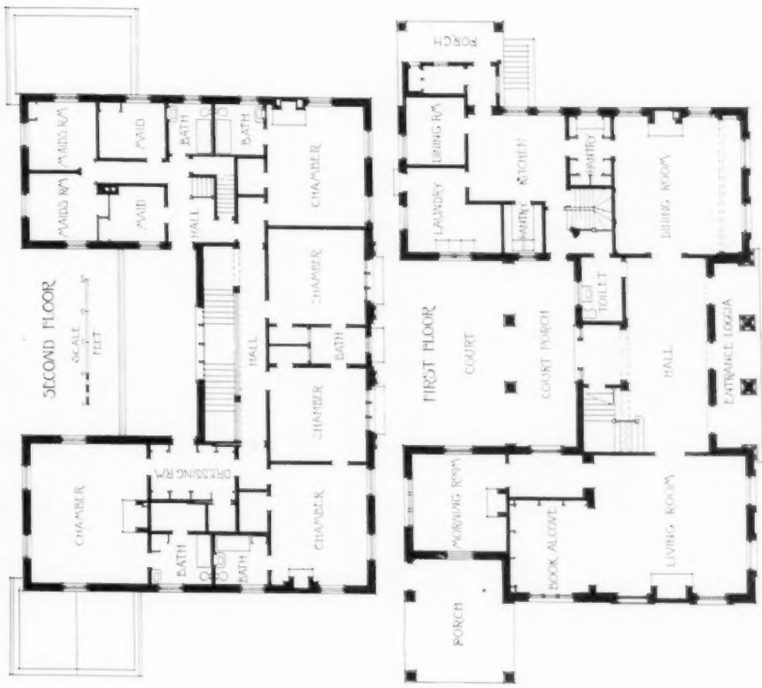
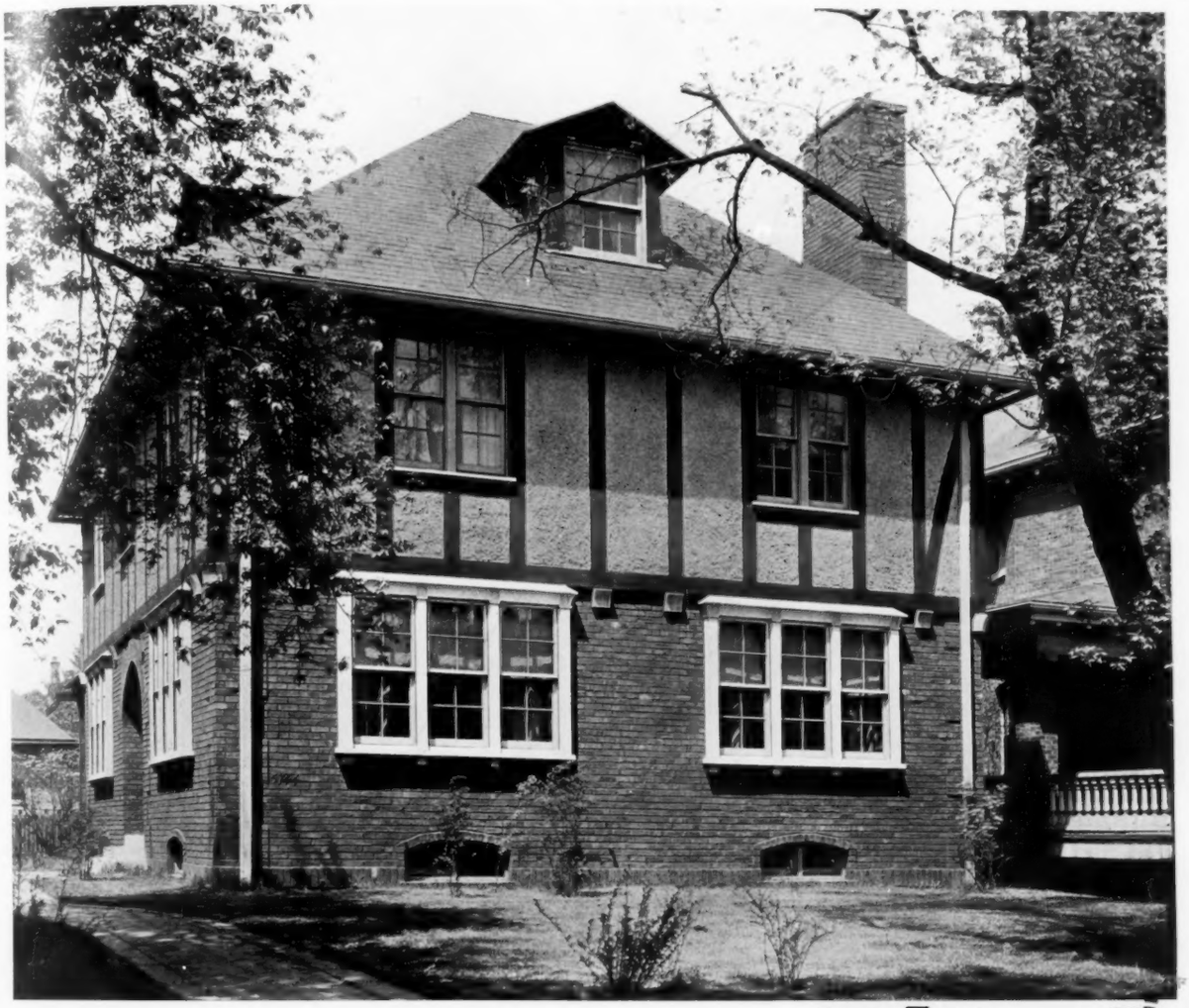
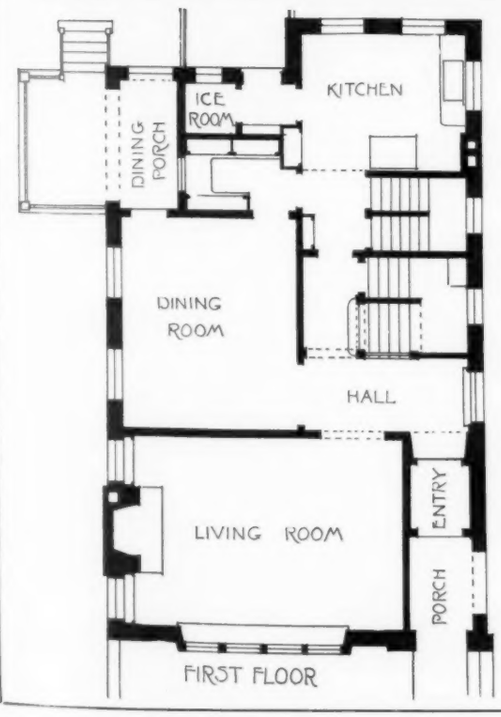


HOUSE AT LAKE FOREST, ILL.
HOWARD VAN D. SHAW, ARCHITECT.



HOUSE, WOODLAWN AVENUE, CHICAGO.
HOWARD VAN D. SHAW, ARCHITECT.

FIRST FLOOR PLAN



FIRST FLOOR

HOUSE, KENMORE AVENUE,

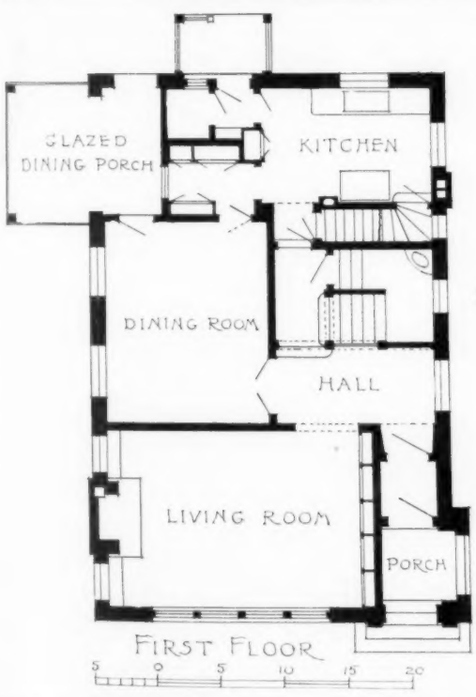
CHICAGO.

HOWARD VAN D. SHAW,

ARCHITECT.

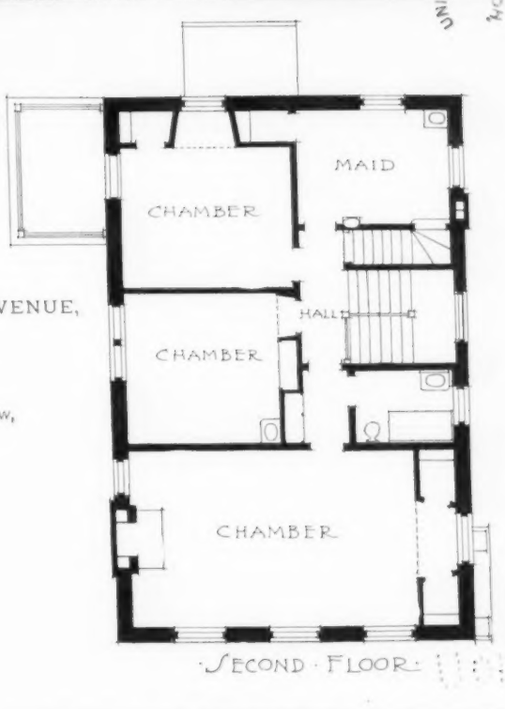
SECOND FLOOR

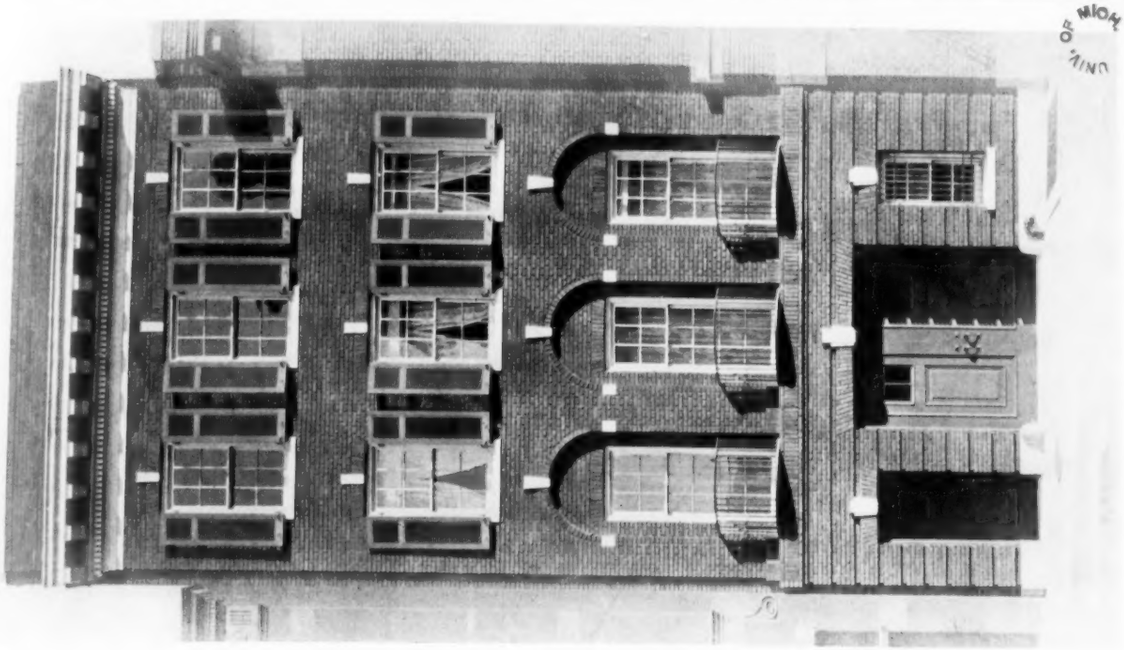
SCALE 0 5 10 FEET



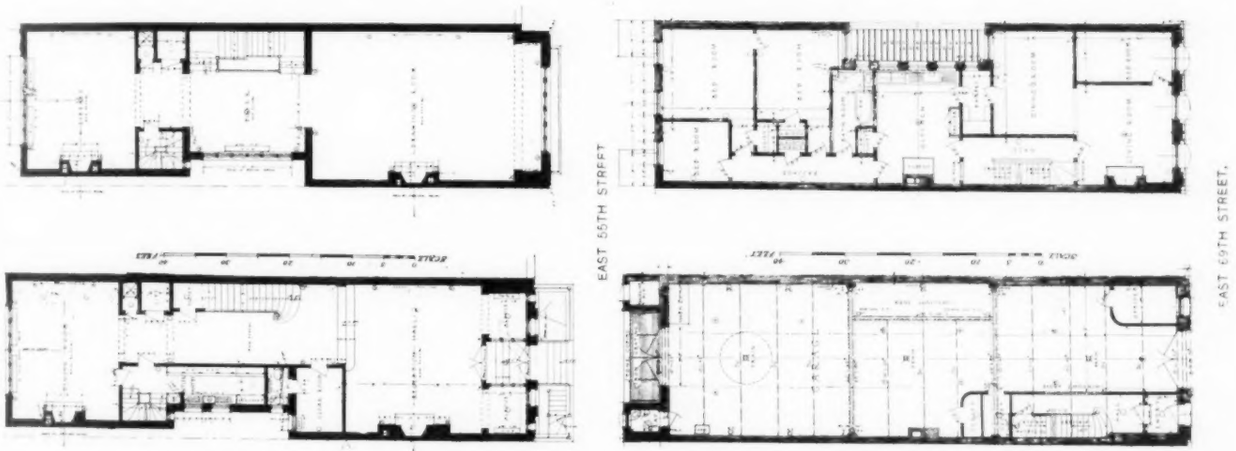
HOUSE, KIMBARK AVENUE,
CHICAGO.

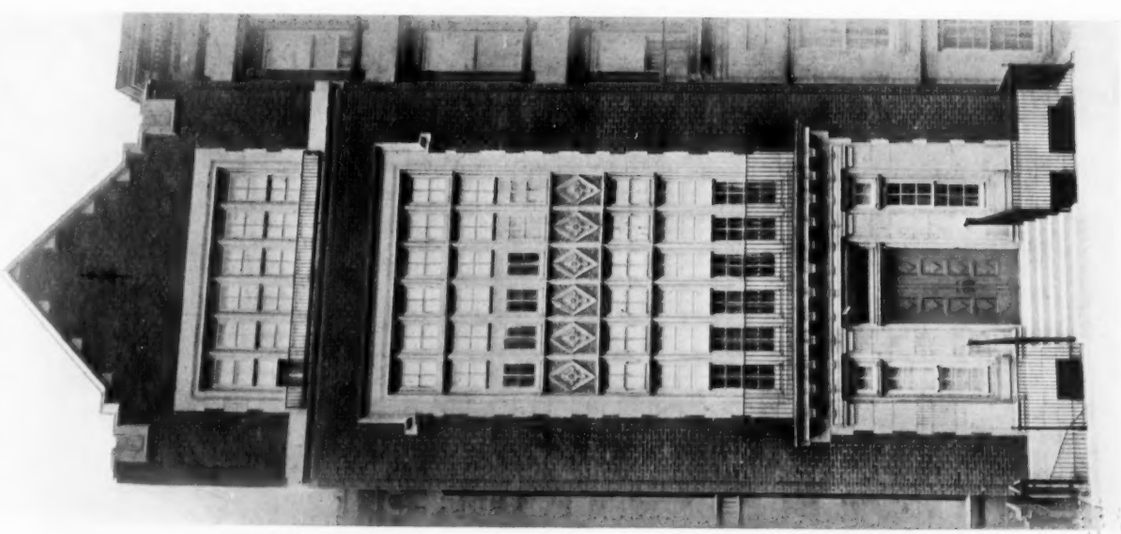
HOWARD VAN D. SHAW,
ARCHITECT.



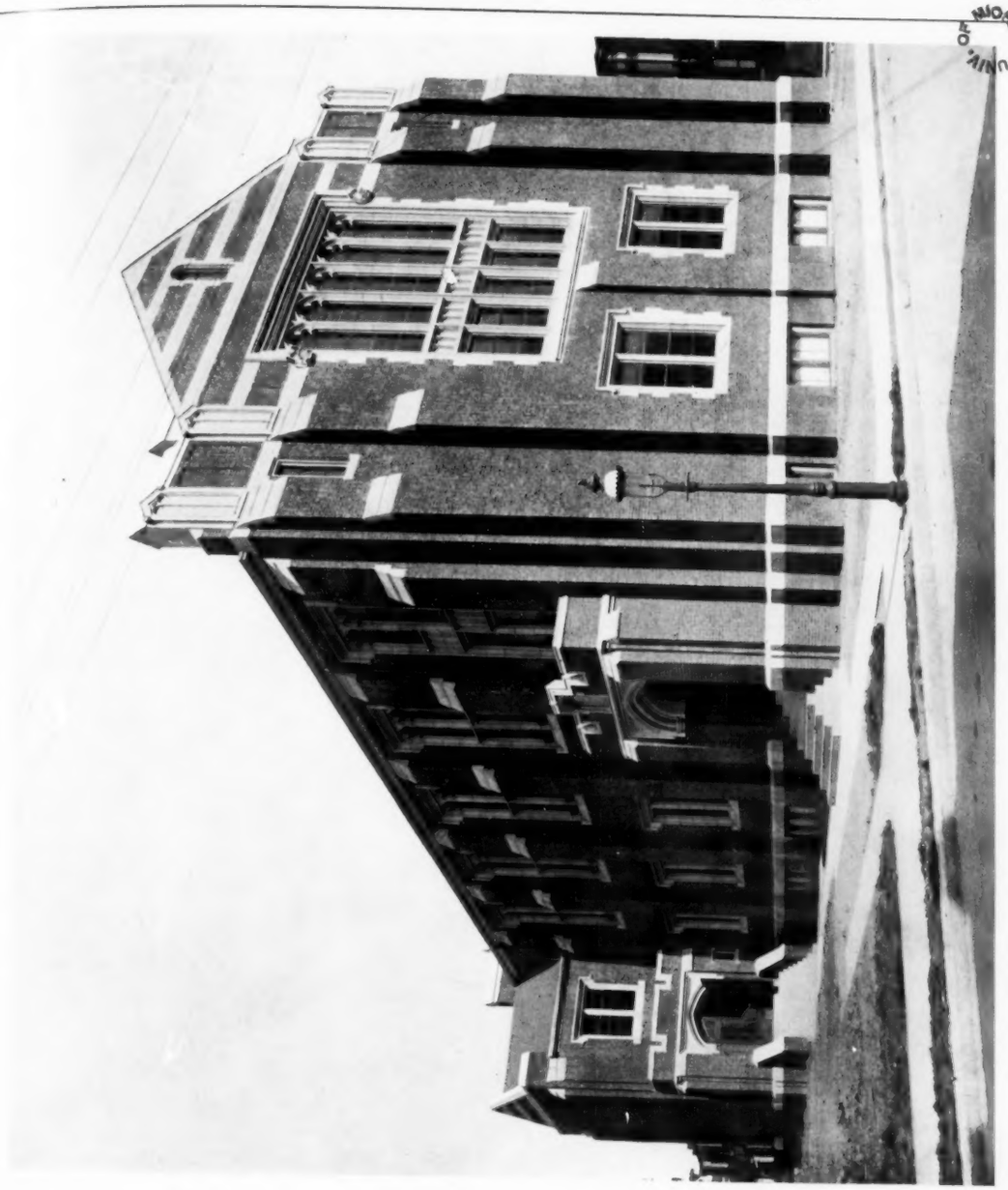


APARTMENT AND GARAGE, EAST 69TH STREET, NEW YORK CITY
ALBRO & LINDEBERG, ARCHITECTS.

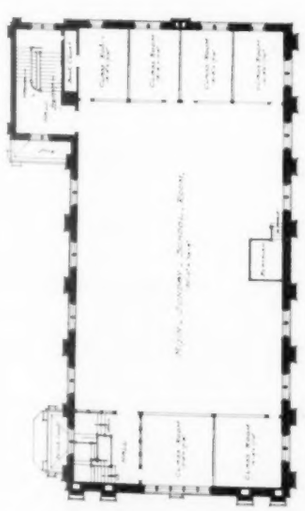


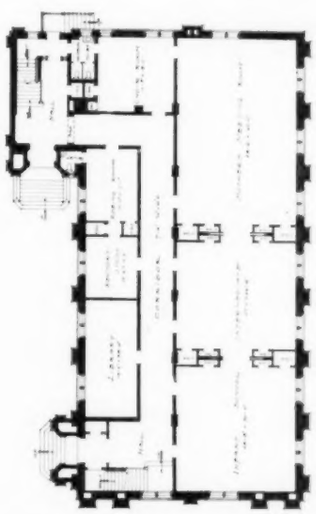


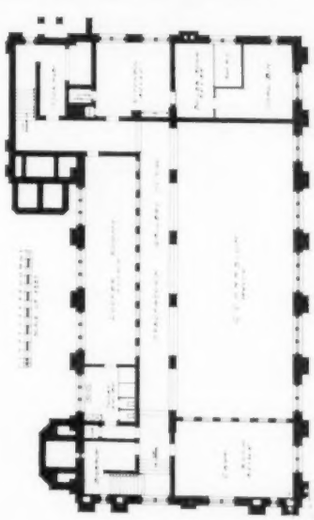
HOUSE, EAST 55TH STREET, NEW YORK CITY.
ALBRO & LINDEBERG, ARCHITECTS.



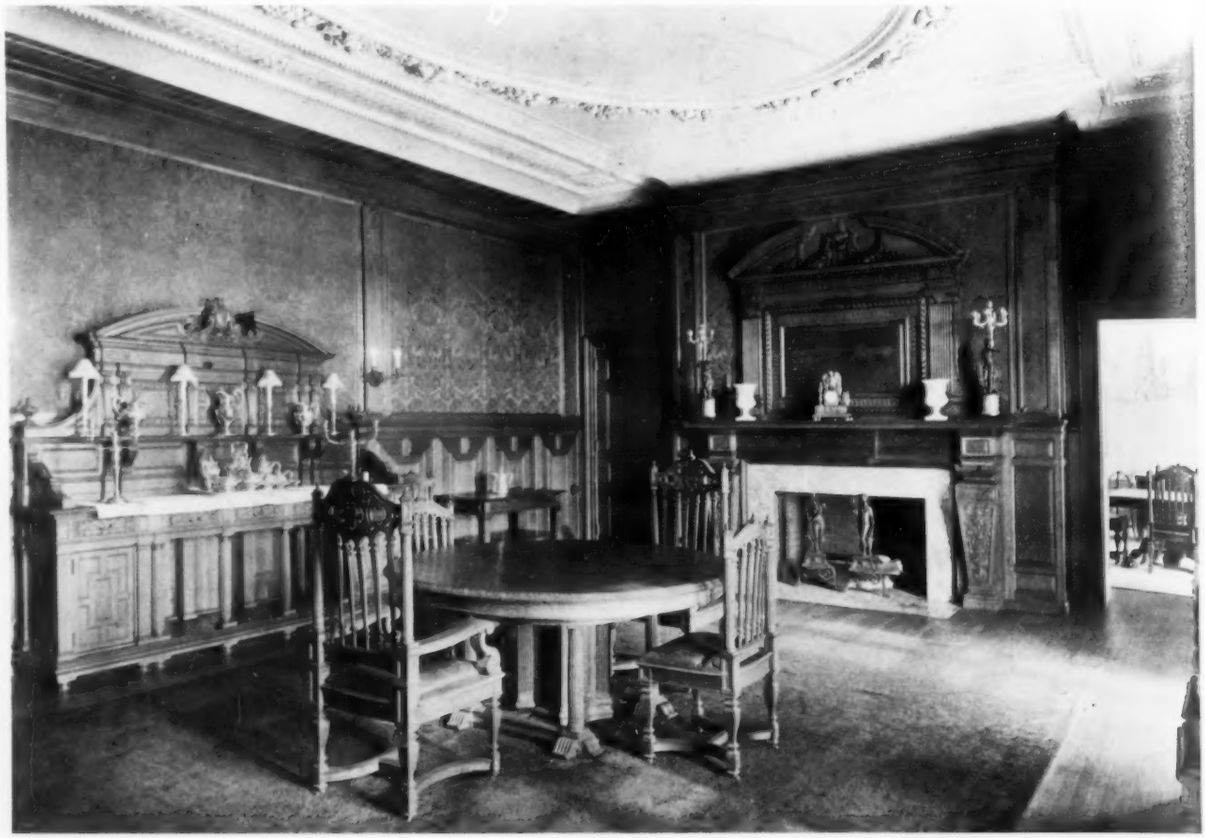
CHAPEL OF THE CHURCH OF THE HOLY APOSTLES, PHILADELPHIA, PA.
THOMAS, CHURCHMAN & MOLITOR, ARCHITECTS.







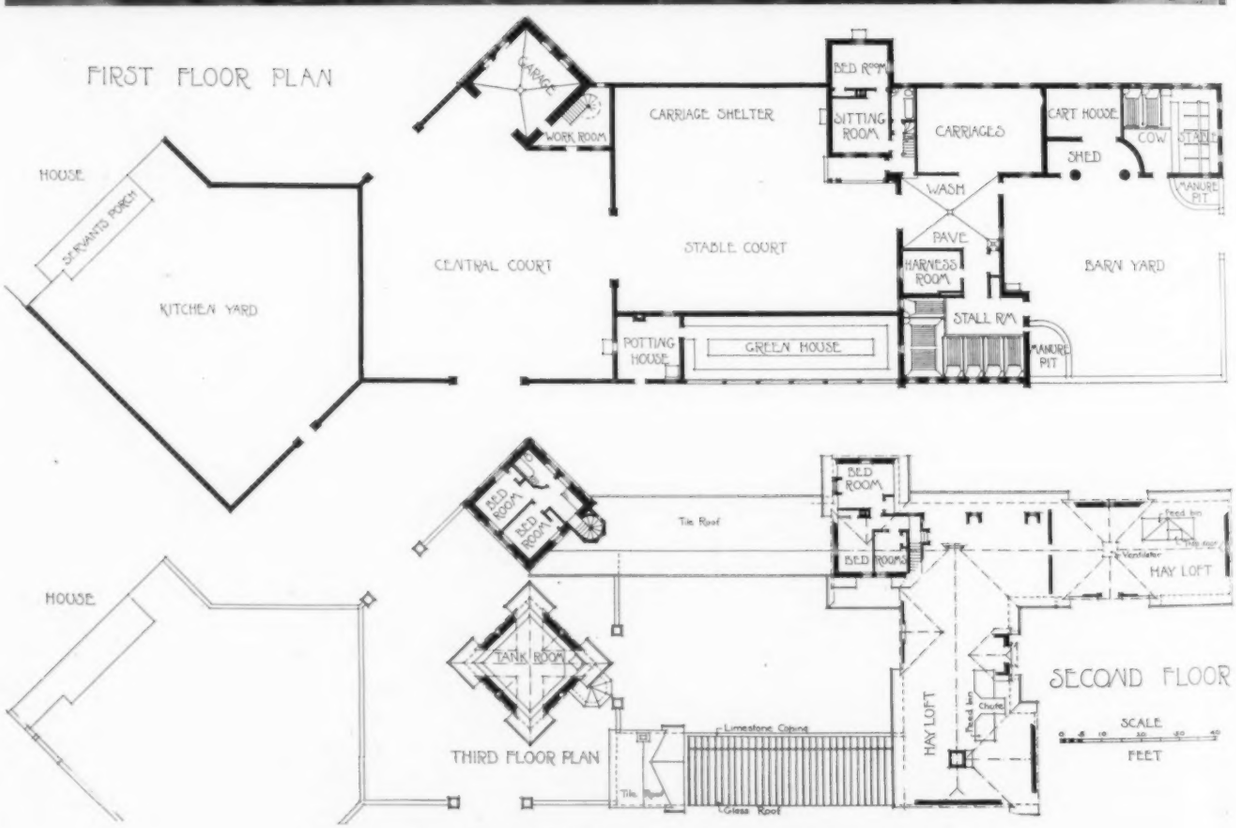
BASEMENT PLAN.



INTERIOR VIEWS.

HOUSE IN RADNOR TOWNSHIP, DELAWARE COUNTY, PA.

GEORGE BISPHAM PAGE, ARCHITECT.



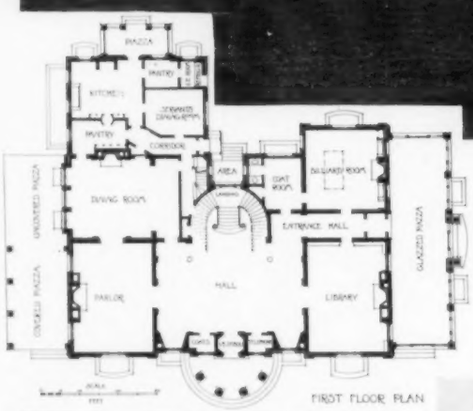
GARAGE, RADNOR TOWNSHIP, DELAWARE COUNTY, PA.

GEORGE BISPHAM PAGE, ARCHITECT.

HOUSE AT LAKE FOREST, ILL.
FROST & GRANGER, ARCHITECTS.

Uor M

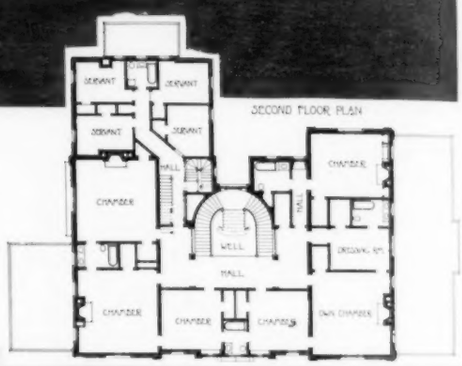
HOUSE AT LAKE FOREST, ILL.
FROST & GRANGER, ARCHITECTS.



FIRST FLOOR PLAN

HOUSE AT
WILLIAMSTOWN, MASS.

WINSLOW & BIGELOW,
ARCHITECTS.



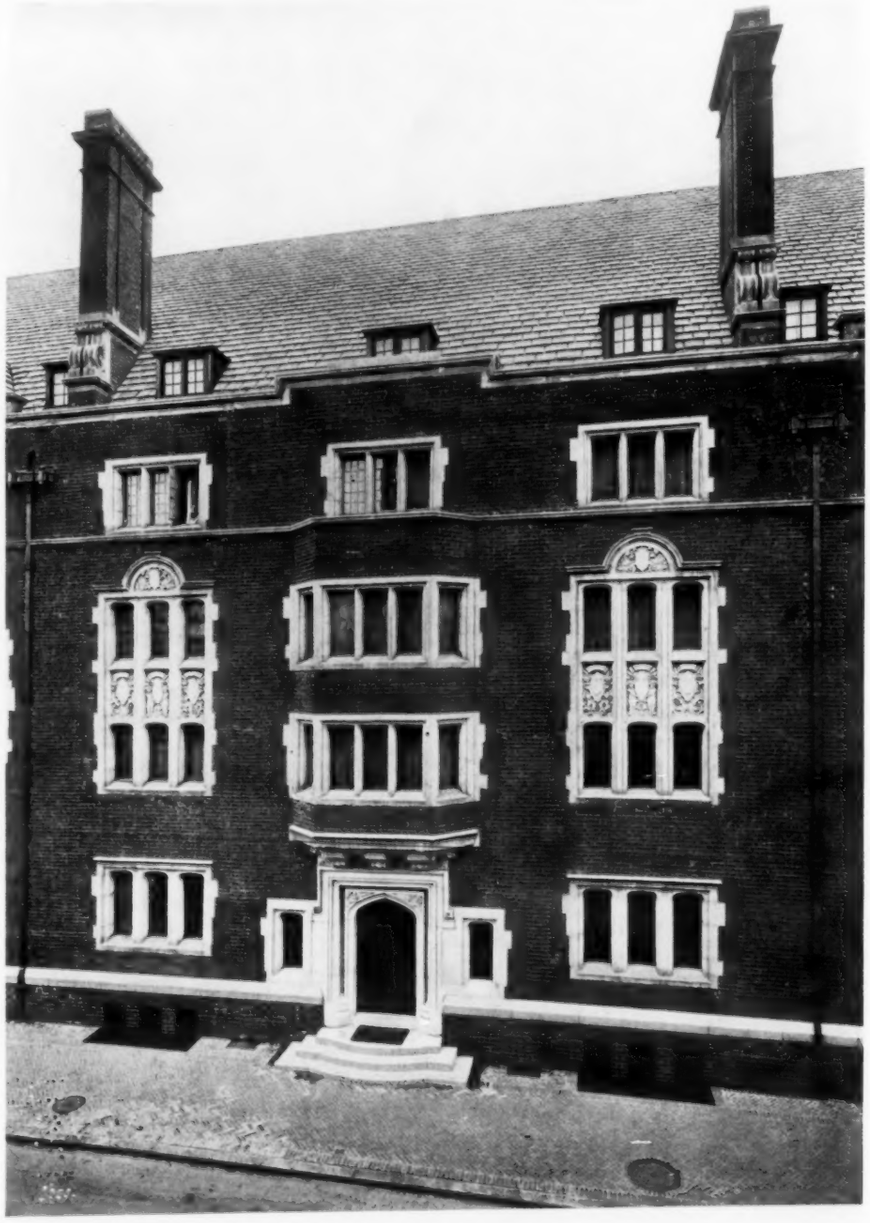
SECOND FLOOR PLAN

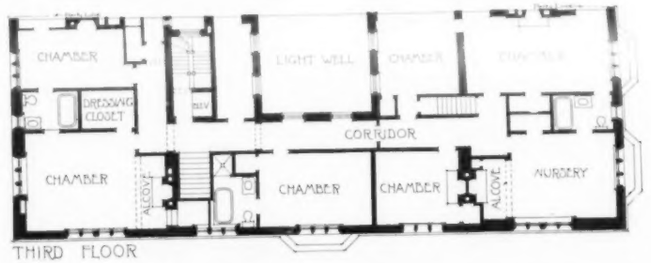
DETAIL OF PORTICO.

HOUSE AT WILLIAMSTOWN, MASS.

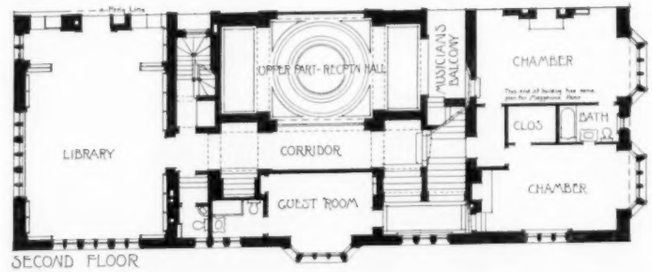
WINSLOW & BIGELOW, ARCHITECTS.

HOUSE AT PHILADELPHIA, PA.
FRANK MILES DAY & BROTHER, ARCHITECTS.

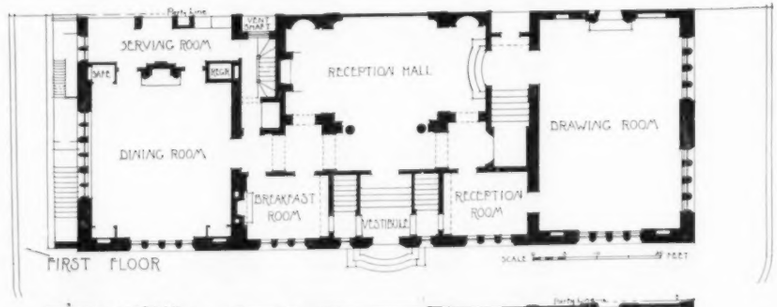




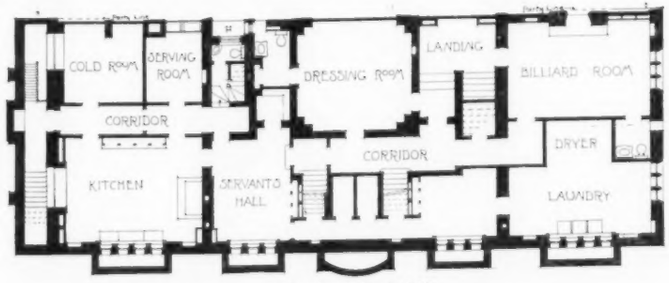
THIRD FLOOR



SECOND FLOOR



FIRST FLOOR



BASEMENT FLOOR

HOUSE AT PHILADELPHIA, PA.

FRANK MILES DAY & BROTHER, ARCHITECTS.

INTERIOR VIEWS.

HOUSE AT PHILADELPHIA, PA.

FRANK MILES DAY & BROTHER, ARCHITECTS

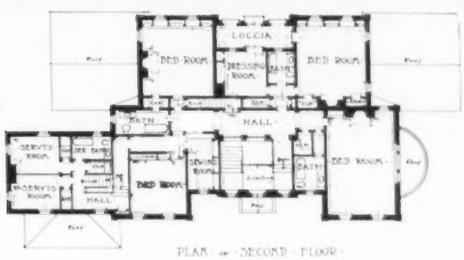
INTERIOR VIEWS.

HOUSE AT PHILADELPHIA, PA.

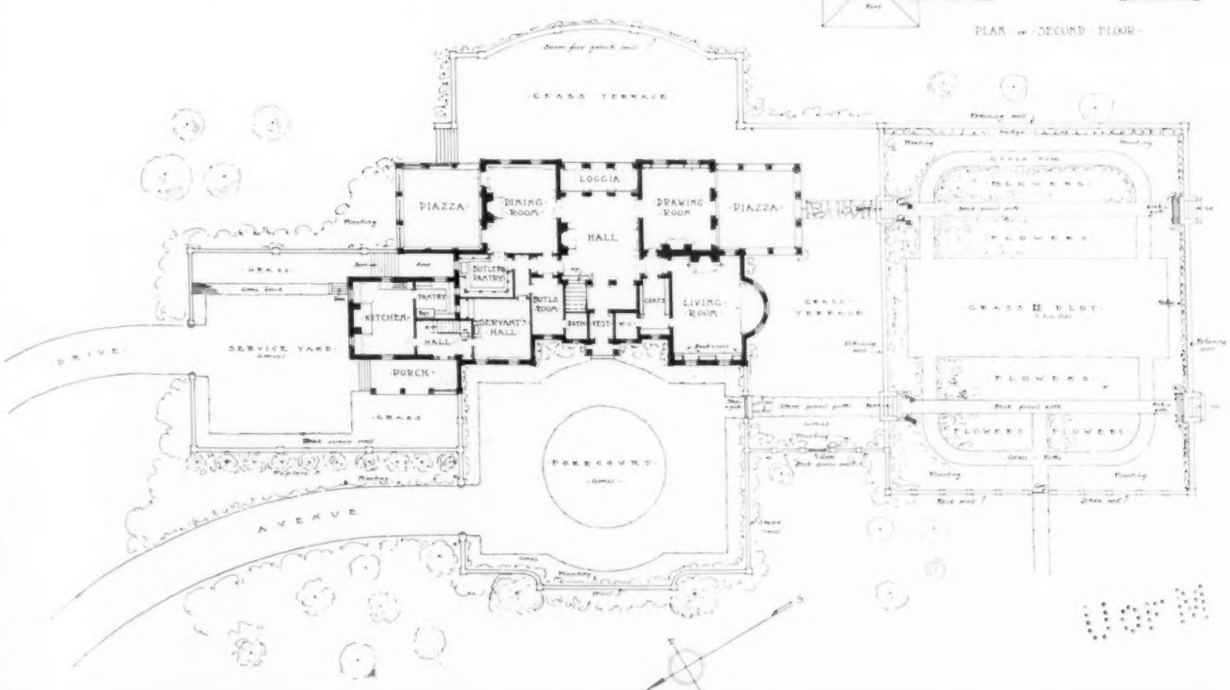
FRANK MILES DAY & BROTHER, ARCHITECTS.

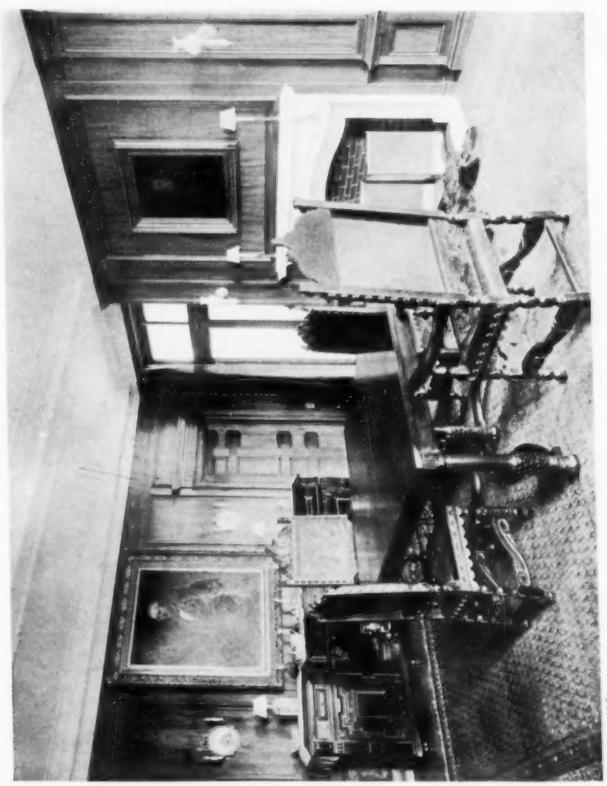
A HOUSE AND GARDEN
AT WENHAM, MASS.

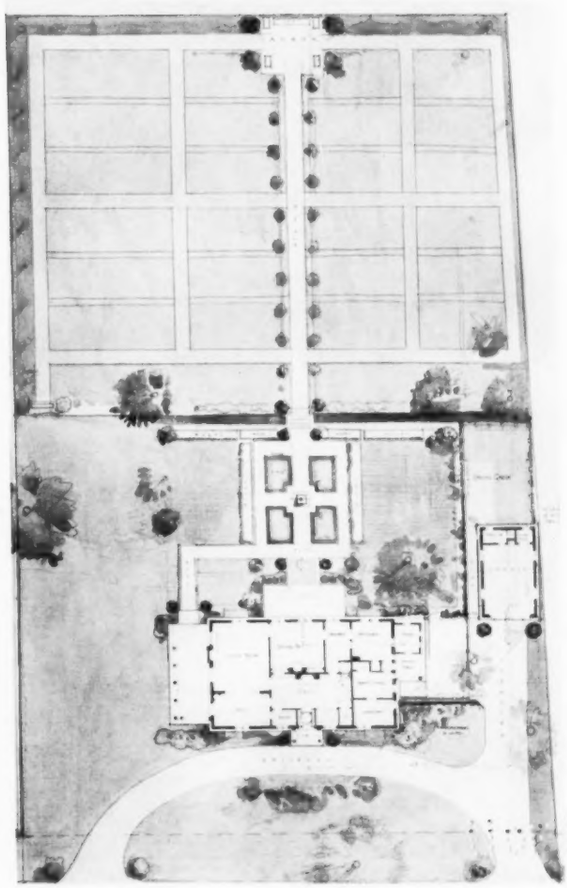
WILLIAM G. RANTOUL, ARCHITECT.



PLAN OF SECOND FLOOR.





A HOUSE AND GARDEN AT WENHAM, MASS.
WILLIAM G. RANTOUL, ARCHITECT.

HOUSE AT ARDSLEY-ON-THE-HUDSON, N. Y.
DELANO & ALDRICH, ARCHITECTS.